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TESIS DOCTORAL

Essays on Macroeconomics and Financial Restrictions

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DEPARTAMENTO DE ECONOMÍA

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Abstract

Access to credit during crises is essential for both private and public institutions. For private firms, access to credit can contribute to keep employment and investment despite lower sales. For public institutions, better access to credit can balance public budgets when tax revenues decrease. But access to credit is not unlimited, it is subject to financial constraints. With this thesis I seek to study how financial constraints affect macroeconomic dynamics.

In chapter 1, I analyze whether the financial structure of small and young firms had a negative effect on their employment and investment decisions during the last crisis. In order to answer that question I follow two steps. First I describe in detail the particular financial structure of small and young firms during the period 1991-2012, using a rich panel data on Spanish manufacturing firms. I document stylized facts about financial patterns of Spanish firms comparing firms of different sizes and cohorts. One of the main results is that smaller and younger firms arrived at the onset of the crisis with more total leverage and more bank dependency. Another key finding is that smaller and younger firms experienced a deleverage process during the last crisis, since they could not easily substitute bank leverage by other leverage. Secondly, I assess the real effect of these particular financial features of small and young firms. I propose two regressions to compute the effect of bank leverage and deleveraging on job destruction and investment during the crisis. The main findings are that bigger bank leverage and deleveraging had a negative real effect only on small firms.

Chapter 2 is motivated by two empirical facts uncovered in chapter 1. Firstly, from 2008 to 2012 bigger firms kept total amount of debt constant while smaller firms decreased it. Secondly, bigger firms managed to keep total debt constant by better interchanging bank debt and non-bank debt. I undercover these two facts using a rich panel data on Spanish manufacturing firms. In this paper I provide a quantitative macroeconomic framework in line with this evidence. In my model, manufacturing firms have access to two different types of debt: collateralized debt and uncollateralized debt. Collateralized debt represents bank debt, it is obtained from a financial intermediary and requires durable input as collateral. Uncollateralized debt represents trade debt and it is obtained from suppliers when obtaining non durable inputs. Size matters since bigger firms can provide more collateral. Firm size also matters when manufacturing firms and suppliers engage in a Nash bargaining game in order to price trade debt. I find that firms' ability to interchange alternative kinds of debt is relevant for firm growth and dividend

smoothing. In addition, I show that improving trade debt conditions for smaller firms is crucial, since trade debt could have been a source of extra liquidity during crisis.

In chapter 3 I analyze the aggregate effects of governments' delayed payments. During the 2008 recession, some European governments have relied in delaying payments to their suppliers as a way of equilibrating public balances. In Spain, Portugal, Italy and Greece, public late payments are three times higher than the EU average. Which are the aggregate consequences of these governments' late payments? There is a trade-off. On the one hand, by delaying payments to its suppliers, governments can access an additional way of funding public expenses and equilibrating its budget constraint. On the other hand, delaying payments to suppliers could have a negative effect on suppliers' production and employment decisions. In this paper I present a novel DSGE model in which the government can finance itself through delayed payments. The model shows that if the government's supplier has low wealth and/or the government owes high payments, then delaying more payments creates a distortion in the economy. I simulate the model in line with Spain's fiscal shocks from 2008 to 2012, and I analyze the aggregate consequences of using public delayed payments as a fiscal tool instead of other fiscal policies.

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1 Small and young: Financial vulnerability in Spain

1.1 Introduction

A key question for macroeconomists has been how firms react to a financial crisis. The 2008 recession has renewed the interest on assessing which firms can be more vulnerable to adverse financial shocks. This vulnerability is very likely to depend on each firm's particular financial structure. The aim of this paper is assessing if the financial structure of small and young firms had a negative effect on their employment and investment decisions during the last financial crisis. In order to answer that question I follow two steps. First I provide a detailed description of the particular financial structure of small and young firms. I use a panel data on Spanish manufacturing firms provided by Encuesta Sobre Estrategias Empresariales (ESEE from now on, survey of business strategies) to document stylized facts about financial patterns of Spanish firms during the period 1991-2012. This way I can uncover the differences among firms of different sizes and cohorts with respect their financial structure. Secondly, I test if these differences matter when firms undertook employment and investment decisions during the last crisis.

In the first step I provide financial stylized facts from a cross sectional perspective and from a life cycle perspective. The cross section analysis consists on a comparison of firms of different sizes[1] with respect the following key variables: Total leverage, bank and other leverage, deleverage rates, current assets, and volatility of bank leverage[2]. The main conclusions are that smaller firms at the beginning of the crisis had more total leverage, more bank dependency and had to deleverage more during the crisis years (from 2008 to 2012). Small firms were unable to keep leverage constant, and were also unable to interchange bank leverage by other type of leverage at early crisis years. Other results are that current assets do not affect deleveraging patterns, and that bank credit is more volatile for big firms. In the life cycle analysis I compare the performance of firms born in different cohorts with respect the following variables: Total leverage, bank leverage and total employment. The main results are that younger cohorts reached the financial crisis with less employees, more total leverage, more bank leverage, and they had to deleverage more during crisis. Other results from this section are that on average: manufacturing small firms are born with 20 employees, 75% of total leverage, and 23% of bank leverage. During their life cycle, firms grow in size, reduce their total leverage, and try to reduce their bank dependency. [3]

[1]Small firms have from 10 to 50 employees, medium firms from 51 to 250 employees, and big firms from 251 above.

[2]See appendix to see definitions of the variables.

[3]If the firm size distribution was stationary, cross sectional analysis would have been enough to un-

The most relevant facts from the first part are that smaller and younger firms had more bank leverage and had to deleverage more during the last crisis. In the second part I perform two regressions to test the real effects (on job destruction and on investment) of these facts. On the one hand, I test the effects on job destruction and investment of being attached to bank leverage. I find that bank leverage affects negatively employment growth only for small and medium firms and only during the recent credit crunch[4]. I also find that during a credit crunch, bank leverage has more significant and negative effect on job destruction that other leverage. In addition, bank leverage has a strong and negative effect on investment only during the investment crunch of 2009, and this crunch is significant only for medium firms. On the other hand, I estimate the effects on job destruction and investment of deleveraging. I find that deleveraging is significant only for small firms. Specifically, it has a significant negative effect on employment growth only during sales crunch. And deleveraging has significant positive effect on investment growth during normal times but becomes negative during sales crunch. I consider that the best estimation technique is system generalized method of moments by Blundell-Bond (1995), since the data set from ESEE has a small time span but a large number of firms per year, both employment and investment depends on their own past, and most of the variables that I include in the regression are not strictly exogenous.

This paper is related to three types of literature. Firstly, to the literature that relates firms' vulnerability and capital structure of firms. Traditional wisdom about firm's vulnerability was set by Schumpeter. According to him, the old and nonproductive firms should be the most vulnerable during a crisis (Schumpeter, 1942), through the process of *creative destruction.* This term refers to the industrial mutation inherent to market economies in which the old is killed by the new. My conclusions contradict this traditional point of view, since I show that the most vulnerable firms are the smallest and youngest[5]. In more recent literature, there is a lack of descriptive work with firm level data about financial patterns.

derstand firm dynamics. Gibrat (1931) established that firm size distribution is stable and follows a log normal. Until end of the 80's this was still the main view in the literature. Since then, some studies show that the distribution of firms can change. Cabral and Mata (2003) showed that for a given cohort, distribution of firms gradually changes. Moscarini and Postel Vinay (2009) showed that variance of distribution of firms is procyclical, i.e. the distribution changes with the cycle. Moreover, the recent financial crisis has changed the firm size distribution. Therefore a life cycle analysis is convenient.

[4]The description of credit crunch, investment crunch and sales crunch can be found in section 1.3 and in the appendix, section 1.5.1.

[5]The appendix shows that creative destruction is not necessarily true for Spanish firms in recent crisis, since the small and young firms, regardless of productivity, are the more vulnerable.

Among the few existing examples, most of them do not include data about the recent financial crisis. An example is Kennedy and Slock (2005) who establish a link between financially vulnerable firms and macroeconomic activity. Unfortunately they focused only in big firms. Kalemli et al. (2012) recollected leverage stylized facts, but their focus was mainly in US banks. Others like Cooley and Quadrini (2001) and Arellano et al. (2012) also document that small firm tends to have more leverage in financially developed countries, but they do not distinguish between different kinds of leverage, and they cannot account for the most recent financial crisis. González (2012) found that higher leverage and maturity increases firms' vulnerability during the recent crisis, but they do not make a distinction between kinds of leverage, and they focus in developing economies. To the best of my knowledge, this is the first attempt to document financial patterns in a developed country with micro level data, differentiating between bank and other leverage and considering two different crises.

The second strand of literature is the one related to firms' financing during life cycle. There have been successful attempts to document how financial restrictions affect firms' life cycle like Cooley and Quadrini (2001), and how firms' financing behavior changes during life cycle, like DeAngelo et al. (2006). Mac an Bhaird (2010) documents very well the different stages of financing during the life cycle of a firm. My contribution here is that, not only I document the behavior of firm financing during life cycle, but I also describe the varied financing behaviors of different cohorts once the financial crisis started.

Lastly, the third strand of literature is the one that estimates the real effects of the last financial crisis. In order to see the effect of credit supply shock on real variables, researchers have used different variables and different methods of estimation. Chodorow (2014) and Bentolila et al. (2013) exploit differences in banks' health, and they find that weak bank attachment accounts for big drops in employment. Some others exploit the differences in long term maturity debt, liquidity risk or total leverage in order to find real effects caused by the financial crisis. For instance, Garicano and Steinwender (2013), who also use the ESEE database, and Almeida et al. (2012) compute the effect of long maturity debt and liquidity risk on corporate investment. Boeri et al. (2013) and Benmelech et al. (2011) look at the debt maturity and cash flows effect on job destruction. Many of these studies find that bigger leverage amplifies the real effects of a financial crisis. However, they discuss total leverage, not different kinds of leverage. Here I have two contributions: First, I focus on the effect of banking leverage versus other leverage on employment, instead of only taking into account total leverage. This is an analysis that to the best of my knowledge has not been conducted. Buca and Vermeulen (2012) also focus in bank and other leverage, but they are only interested on the effect on corporate investment and they do not account for more than one financial crisis. And secondly, also to the best of my knowledge there has been no attempt to test for the real effects of deleveraging.

The remainder of the paper is organized as follows: Section 1.2 describes the particular financial structure of small and young firms, and presents patterns and stylized facts about financial variables of Spanish manufacturing firms. It is divided in 1.2.1: cross sectional analysis, and 1.2.2: life cycle analysis. Section 1.3 tests if the financial structure of the small and young firms has implications for real variables, employment and investment. Section 1.4 contains the conclusion. Section 1.5 is the appendix, in which I describe, among other aspects, why Spain is an interesting case. I also present evidence of the existence of a credit crunch.

1.2 Financial structure of Spanish firms. Stylized facts

In section 1.2 I document stylized facts about financial patterns of Spanish firms during the period 1991-2012. This way I can uncover the differences among firms of different sizes and cohorts with respect their financial structure. I provide these facts through a cross section analysis (section 1.2.1) and a life cycle analysis (section 1.2.2). All the data comes from ESEE. This survey is conducted by the Spanish government and the SEPI foundation. They send a questionnaire to Spanish manufacturing firms, getting reliable answers from around 2200 firms each year since 1991. They keep the number of companies interviewed each year constant. Firms are required to answer the questionnaire year after year, and if any firm disappear or stop answering to the questionnaire, then ESEE substitutes it with a firm of similar characteristics. The survey provides data about firms of all sizes, but I disregarded firms with less than 10 employees because there were not sufficient observations about them. The panel data is not representative for micro firms The sample is representative for the rest of sizes in Spain. It contains 3% of total small manufacturing firms (around 1000), 5% of medium manufacturing firms (around 600), and almost 20% of big manufacturing firms (250 approximately). First, I list the main facts uncovered in both analysis:

1.2.1: Facts regarding cross section analysis

Whole sample facts

1 Small firms had more total leverage during the period 1991-2007

2 Big firms are less bank dependent:

- Big firms have less bank leverage
- Bank leverage is more volatile for big firms

2008 crisis facts

3 Correlation between size and leverage is reverted:

- Small and medium firms deleverage during crisis. Big firms do not
- Big firms manage to compensate better bank leverage by other leverage

4 Small firms' leverage patterns are not affected by current assets

1.2.2: Facts regarding life cycle analysis

5 Small firms are born on average with 22 employees and start growing until the crisis:

- Firms born from 1991 to 1994 had been able time to hire up to 40-50 employees on average at the start of the crisis
- Firms born after 1998 did not have time to grow as much

6 Firms are born on average with 75% of leverage and start deleveraging:

- In 2008, firms born from 1991 to 1994 had on average less leverage than younger ones
- Firms born after 1998 had to deleverage more during crisis

7 Firms are founded with 23% of bank leverage and reduce it over years

1.2.1 Cross sectional analysis

Section 1.2.1 describes in detail the facts of the cross section analysis. For all figures of this section, blue dotted line refers to small firms, red line refers to medium firms and black line refers to big firms. Facts of this section concern the following variables: Total leverage, bank and other leverage, deleverage rates, interchangeability of bank leverage and other leverage, and volatility of bank leverage. The description of the variables is in the appendix.

Fact 1: Small firms had more total leverage during the period 1991-2007

In table 1 I present the main data for this section. In this table it can be seen that from 1991 to 2007, the bigger the firm, the less total leverage. Small firms had on average more than 60% of total leverage, while medium and big firms had slightly more than 56% and 55% respectively. Figure 1 shows the evolution of total leverage. It can be seen that smaller firms (blue dotted line) have systematically more total leverage during the period 1993 to 2007. While medium (red) and big (black) first kept it roughly constant, small firms increased their leverage on average until 63% in 1997. Since 1997, they decreased on average their total leverage until 2007, when they ended up with around 58%.

	Average total debt, % 1991-2007	Average other debt, % 1991-2012	Average bank debt, % 1991-2012
Small firms	60.6	41	19
Medium firms	56.1	37.2	18.9
Big firms	55.1	14.4	14.4
	Change total debt,% 2007-2012	Std dev of bank debt growth 1991-2012	Std dev of bank debt growth 2007-2012
Small firms	-11.9	0.87	0.81
Medium firms	-9.2	0.83	0.74
Big firms	-1.2	0.91	1.01

Table 1: Main facts, cross sectional analysis.

Fact 2: Big firms are less bank dependent

Big firms are less bank dependent because they rely less in bank leverage and they can accommodate easier their bank credit position. For small firms this is exactly the opposite. In order to show this, I document the relationship between: i. Firm size and the amount of bank leverage, and ii. Firm size and the volatility of bank leverage.

i. During the whole sample, big firms have on average less bank leverage than other firms. This can be observed in table 1,+ where I show the average of other leverage and bank leverage for different

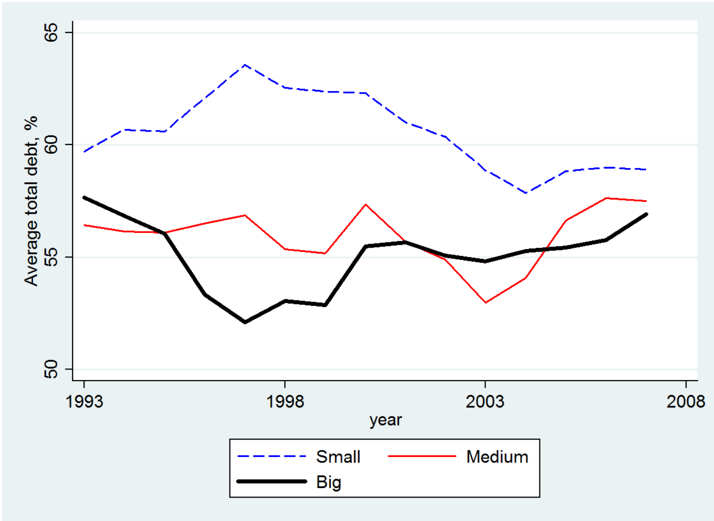
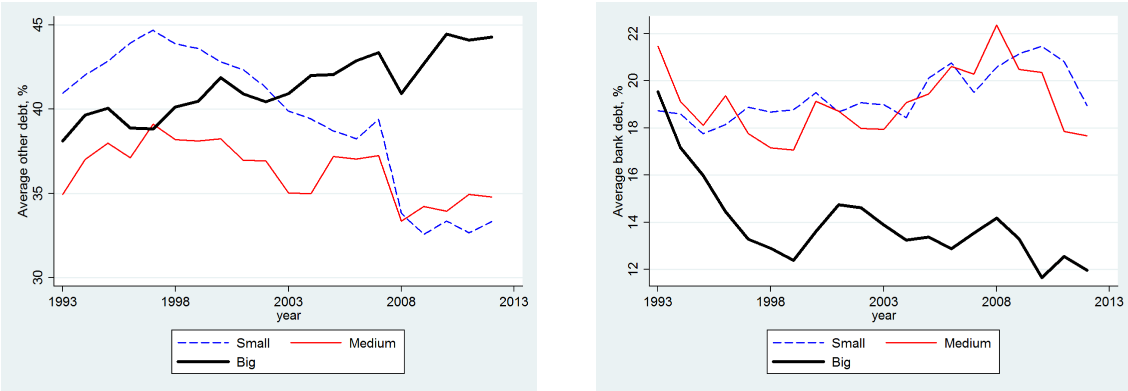


Figure 1: Total leverage, 1993-2007

sizes and for the entire sample. Small firms have on average 19% of bank leverage and medium firms have 18.9%. However, big firms have considerably less bank leverage on average, 14.4%. This low bank dependence is the result of an evolution since 1991 in leverage composition of big firms. Figures 2a and 2b capture this evolution. From 1991, big firms have substituted bank leverage by other leverage. Note that big firms had 36% of other leverage at 1991, and it increased over the years until reach 44% at 2012. On the other hand, big firms had 20% of bank leverage at 1991, and by 2012 they had 12%. Small and medium firms did not experience such a transition. Small firms started the sample with 37% on average of other leverage, and at the end of the sample it was reduced until 33%. Bank leverage for small firms has been constant for the entire period, starting with 18% and ending with 18.9%. Medium firms hardly changed the proportion of other leverage during the sample and their bank leverage drop from 22% on 1991 to 18% of bank leverage on 2012. Consequently, since 1991, big firms have been relying less and less on bank credit, while exactly the opposite happened for small firms. Medium firms also experienced a significant drop in bank leverage, although not as substantial as the one experienced by big firms.

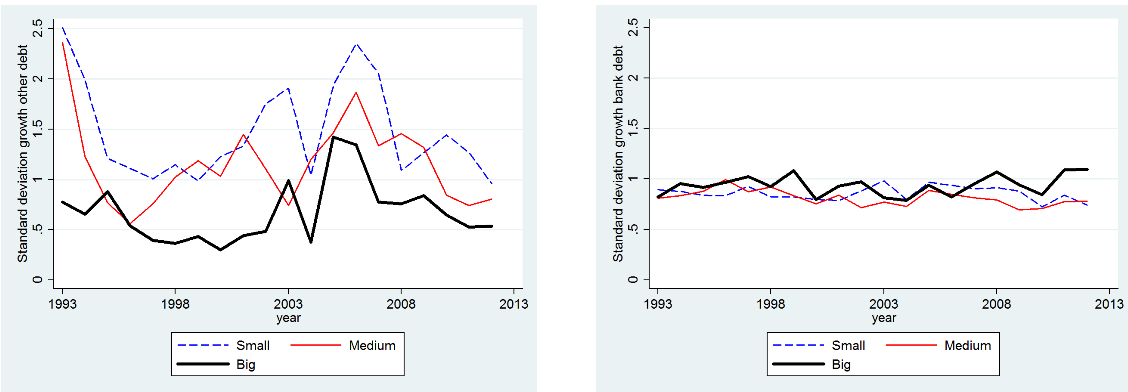
ii. Bank leverage has more dispersion for big firms. In table 1 I show the standard deviation of bank leverage growth for the entire sample and for the recent crisis, 2007-2012. For the whole sample, dispersion of bank leverage growth for big firms is higher than for the rest of the firms, and this difference is exacerbated during the recent economic crisis. In figures 3a and 3b it can be appreciated that big firms have the lower dispersion of other leverage growth. Moreover, notice that only for big firms, dispersion



(a) Other leverage (b) Bank leverage

Figure 2: Other leverage and bank leverage, small, medium and big firms, 1993 to 2012

of other leverage growth is lower than the dispersion for bank leverage growth. To recap, fact 2 reveals that big firms are less bank dependent because: i. They have less bank leverage than the rest of the firms, and ii. They accommodate the level of bank leverage more frequently.



(a) Volatility of growth of other leverage (b) Growth of bank leverage

Figure 3: Volatility of other leverage and bank leverage growth, small, medium and big firms

Fact 3: Correlation between size and leverage has been reverted

Before the 2008 crisis, the correlation between size (measured as asset size) and total leverage was negative. This is a feature consistent with the literature. Arellano et al. (2012) found that in financially developed economies, bigger firms tend to use less leverage than smaller firms. However, after 2008 crisis, I find that this relation has been reverted. In table 2 I present the correlations between size and leverage. From 1991 to 2007, this correlation has been significant and negative, around -10%. However, since the beginning of the crisis this correlation has turned out to be significant and positive, around 3%. The reason for this is that, since 2008, small and medium firms have experienced a process of deleveraging and big firms have managed to keep leverage constant. Figure 4 shows the evolution of total leverage from 2007 onwards. In 2007, a year before the crisis started, small, medium and big firms had very similar levels of leverage, around 57% above total assets. However, during crisis, both medium and small firms did deleverage and ended below 52% and big firms managed to keep constant the level of total leverage, with slightly more than 56%. In table 1 I present the percentage change of total leverage of firms in 2012 with respect to 2007. The decrease in total leverage in big firms was only around 1.2% while for medium firms was more than 9% and for small firms almost 12%.

	1991-2007	2008-2012
All firms	-0.1	0.03

Table 2: Correlation size and leverage

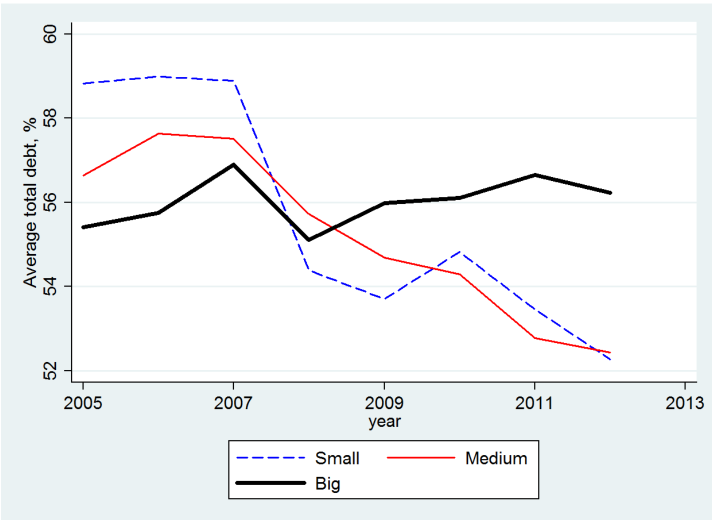


Figure 4: Total leverage, 2008-2012

How did big firms managed to keep leverage constant and why did small and medium firms deleverage? In order to answer that question, I analyze in figures 5, 6 and 7 the growth of bank leverage and other leverage for small (5), medium (6) and big firms (7). Growth of other leverage is in black, and growth of bank leverage is in red. The main lesson from these figures is that big firms interchange better one kind of debt by another. Consequently they avoided total deleveraging during crisis.

Firms of all sizes decreased considerably other leverage during 2008[6]. But big firms were able to rise

[6]Trade credit, delayed payments to workers and long term bonds are some of the components of other leverage. See appendix for a detailed breakdown.

bank leverage during 2008 (red line, figure 7). In addition, the decrease in other leverage was less severe for them. Therefore big firms avoided on average deleveraging that year. On the other hand, small and medium firms were not able to rise bank leverage during 2008 (red line, figures 5 and 6), and drop of growth other leverage was more intense for them. Thus, they faced total deleverage.

After 2008, small and medium firms started decreasing bank leverage, and they continued doing so until 2012. They managed to keep constant other leverage during that time. Big firms started decreasing bank leverage after 2009. But big firms were able to raise slightly more other leverage than medium and small firms on 2009 and 2010, so big firms compensated the drops in bank leverage with increases of other leverage. During 2011 and 2012, small, medium and big firms kept other leverage constant and reduced around 10% of their bank leverage. Remember that bank leverage has less weight in big firms than in small and medium firms. So these drops of bank leverage from 2011 onwards were less important for big firms.

The conclusion from this fact is one of the most relevant ones of this paper: In 2008 there was an enormous decrease of other leverage, and only big firms were able to compensate it with bank credit. During the crisis, the bank credit crunch got worse, and big firms were initially able to compensate by rising other kinds of debts.

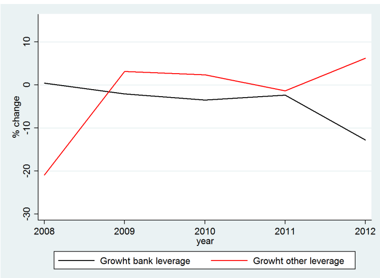


Figure 5: Growth of bank leverage and other leverage. Small firms

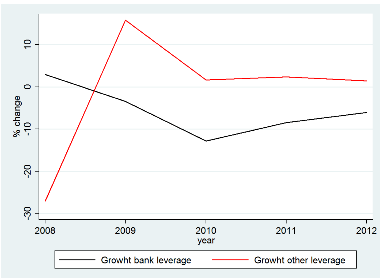


Figure 6: Growth of bank leverage and other leverage. Medium firms

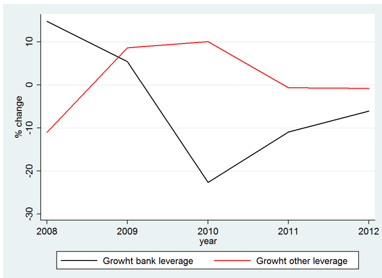


Figure 7: Growth of bank leverage and other leverage. Big firms

Fact 4: Small firms' leverage patterns are not affected by current assets

Small firms have exactly the same pattern of deleveraging independently of the amount of current assets (which is a proxy for liquidity). A similar pattern is observed for medium firms. Regardless of the level of current assets, on average medium firms reduce leverage. Low liquid big firms manage to keep leverage constant, and high liquid big firms even manage to increase leverage slightly. This fact can be noticed in figures 8, 9 and 10, where I show total leverage for small, medium and big firms respectively, differentiating between firms with current assets above the mean (red line) and firms with current assets below the mean (blue line).

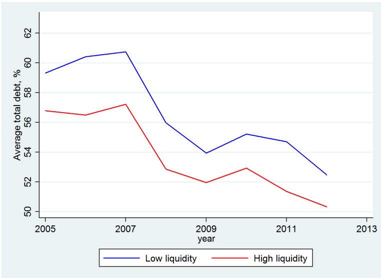


Figure 8: Total leverage and current assets. Small firms

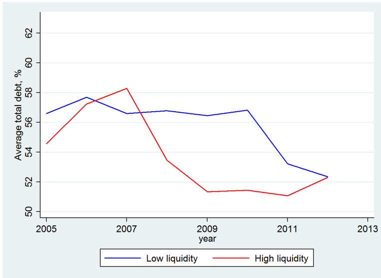


Figure 9: Total leverage and current assets. Medium firms

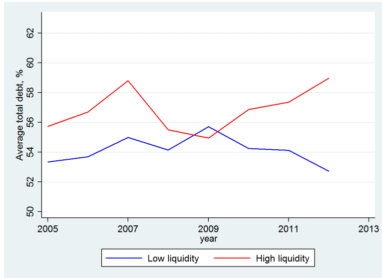


Figure 10: Total leverage and current assets. Big firms

1.2.2 Life cycle analysis

Section 1.2.2 describes in detail the facts of the life cycle analysis. Facts from this section concern the following variables: Total employment, total leverage and bank leverage. For each variable I perform two exercises. First, I compare the behaviour of small firms born in different cohorts. I compare the behaviour of small firms born in 1991, 1994 and 1998. I also compare the behaviour of small firms born between 1991 and 1994, firms born between 1995 and 1998, and firms born between 1999 and 2002[7]. The number of firms in each cohort is not constant, since some firms disappear or just stop answering the survey, so results should be interpreted carefully[8]. Secondly, I compare firms of different ages, i.e. firms that in year 2008 were less than 10 years old (green line), between 10 and 20 years old (blue line), between 30 and 40 years old (red line) and more than 40 years old (black line). For medium and big firms I disregard firms with less than 10 years old because there were not sufficient observations about them.

Fact 5: Small firms are born on average with 22 employees and start growing until the crisis

I compare in figure 11 the behaviour of small firms born in 1991, 1994 and 1998. Firms founded in 1991 and 1994 grew from 25 employees to around 40, 50 employees before the beginning of the crisis.

[7]The number of firms born in 1991 is 55, in 1994 is 60 and in 1998 is 32. Around 20 firms survive the whole period. The number of firms born between 1991 and 1994 is 190, between 1995 and 1998 is 160, and between 1999 ans 2002 is 45. Around 40 firms survive the whole period.

[8]For robustness, I include in the appendix, section 1.5.4, a comparison between cohorts 1991-1994, 1995-1998 and 1999-2002, but keeping the number of firms constant, i.e. I consider only firms that are present during the whole sample. Results do not differ much.

Firms from 1998 started with 25 employees and grew afterward, but at the time of the crisis they had only 34 employees. During the crisis, firms reduced their size. Firms from 1998 returned to their initial employment numbers, reducing their employment size by 40%. Firms from 1994 also decreased considerably the number of employees, around 30%, while the decrease of firms from 1991 is smaller, around 20%.

In figure 12 I compare the behaviour of small firms born between 1991 and 1994, between 1995 and 1999 and between 1999 and 2002. This figure confirms the tendency. Firms from the first generation grew from 20 employees in 1995 up to 40 employees by 2005. During the crisis, their average size was reduced to 30 employees. Firms from the second generation grew from 24 employees in 1999 up to 34 employees by 2007, and they decreased the number of employees down to 25 during the crisis. Firms from third generation had on average 21 employees in 2007, and during the crisis they kept the number employees.

This fact suggests that firms start on average with 22 employees and grow during its life cycle until the crisis. Firms born in the first generations managed to reach 2007 with more employees, and their reduction in size was less intense during the crisis. However, firms born in latter generations did not manage to grow as much, and they reduced more their size during the crisis.

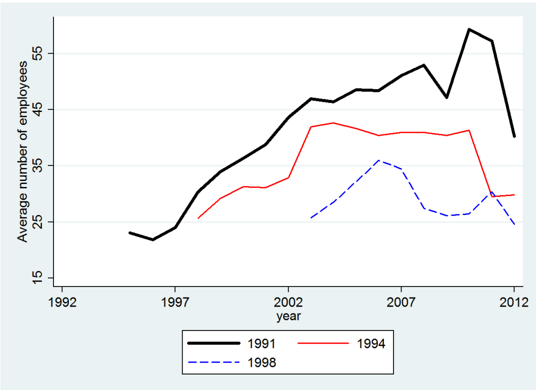


Figure 11: Employment. 1991 vs 1994 vs 1998

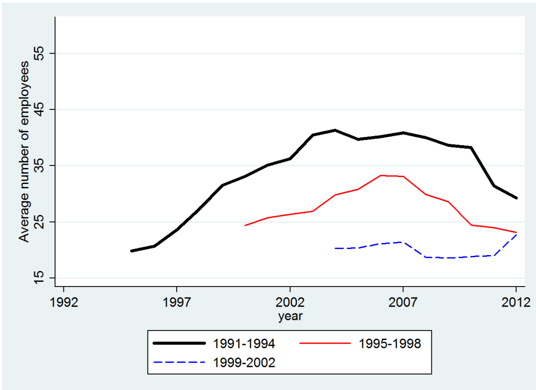


Figure 12: Employment. 91-94 vs 95-98 vs 99-02

Fact 6: Small firms are born on average with 75% of leverage and start deleveraging

In figure 13 I compare the behaviour of small firms born in 1991, 1994 and 1998 regarding total leverage. Firms born in 1991, started with 67% of total leverage, while firms born in 1994 and 1998, started with 73% of total leverage. At the onset of the crisis, firms born in 1991 had reduced their total leverage down to 54%, firms from 1994 down to 65%, and firms from 1998 kept it constant. Firms from the youngest generation did not have time to deleverage as much as their older counterparts. During the crisis, firms born in 1991 and in 1994 managed to keep total leverage constant or even slightly increased it. But firms from 1998 experienced a decrease of 25% of total leverage during the crisis.

I obtain similar conclusions from figure 14, in which I show the results of small firms born between 1991 and 1994, between 1995 and 1999 and between 1999 and 2002. Firms born in 1991-1994 started on average with 75% of total leverage, while firms from 1995-1998 and from 1999-2002 started on average with 77%. In 2007, at the onset of the crisis, firms from the first generation had 62% of total leverage and firms from second generation had 67% of total leverage, while firms from last generation had on average 72% of total leverage. During the crisis, firms from youngest generation are the ones that deleveraged the most.

Comparison among firms with different ages supports the same conclusions from another perspective. In figure 15 and figure 16 it can be noticed that, for small and medium firms, younger firms tend to have substantially more total leverage, and firms tend to slowly decrease their leverage as they get older. Figure 17 suggests that there are not differences for big firms above 20 years respect total leverage behaviour.

To recap, this fact suggests that firms start on average their life cycle with around 75% of total leverage, i.e. with 25% of own funds. During their life cycle, firms of all generations deleveraged at a constant rhythm. Firms from older generations arrived to the onset of the crisis with less leverage than younger ones, and during the crisis they reduced total leverage less than firms born latter.

Fact 7: Small firms are born with 23% of bank leverage and try to reduce it over years

Figure 18 shows that firms start their life with approximately 23% of bank leverage. Firms from 1991 started with 18 % and by 2007 they had to 20%. Firms from 1994 started with 21% and by 2007 they reduced to 17%, they slowly bank deleveraged. Firms from 1998 started with 22% and by 2007 they were still on 24%. During the crisis, firms from 1991 and 1994 did not reduce bank leverage, but firms from 1998 decreased considerably its bank position, ending on average with 10% of bank leverage.

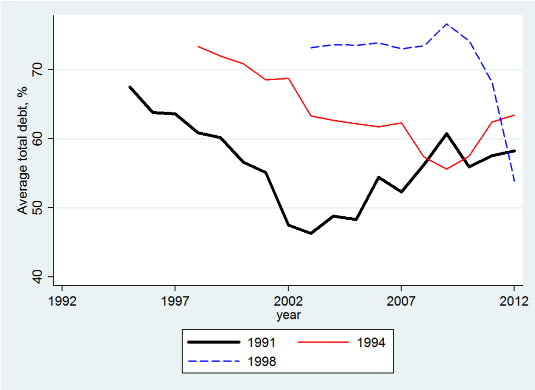


Figure 13: Total leverage. 1991 vs 1994 vs 1998

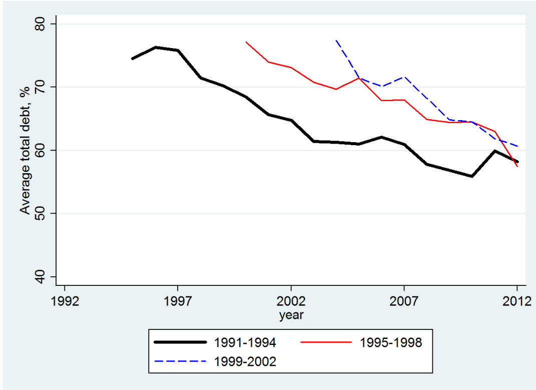


Figure 14: Total leverage. 91-94 vs 95-98 vs 99-02

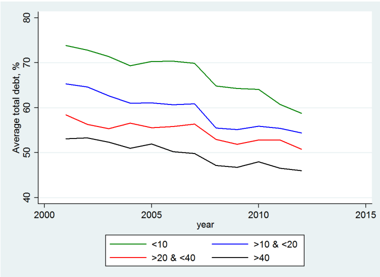


Figure 15: Total leverage. Small firms. Cohort comparison

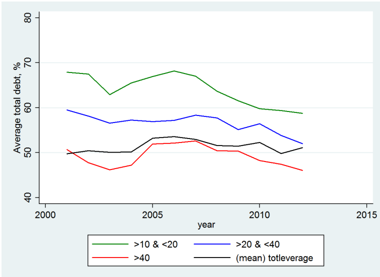


Figure 16: Total leverage. Medium firms. Cohort comparison

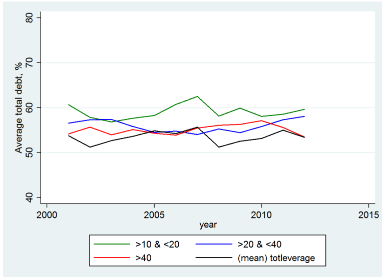


Figure 17: Total leverage. Big firms. Cohort comparison

From figure 19 I draw similar conclusions. Firms from 1991-1994 started with 20% of bank leverage, and firms from 1995-1999 and from 1999-2002 started with almost 25% bank leverage. Firms from 1991-1994 and firms from 1995-1999 reduced their bank leverage down to 17% and 22% respectively in 2007. But firms from 1999-2002 increased their bank levering until 28% in 2007. With bank leverage it happens as with total leverage, fact 6: The more leverage in 2007, the more deleverage during the crisis years. In fact, firms from 1991-1994 almost did not decrease bank debt, firms from 1995-1999 deleveraged from 22% to 19%, and firms from the newest generation deleveraged the most, from 28% to 20%.

Comparison among firms with different ages leads to similar conclusions. From figures 20 to 22, the younger the firm, the more bank leverage it has. This is specially the case for small and medium firms.

This fact suggests that small firms start around 23% of bank leverage. Over the life cycle, firms from all generations reduced their bank leverage exposure. Younger firms did not manage to reduce it before the crisis, and they end deleveraging more than other older firms. Older firms managed to keep bank leverage more or less constant. From figures 20 to 22, the younger the firm, the more bank leverage it has, especially for small and medium firms as figures 20 to 21 reveals.

Conclusions from section 1.2

I highlight the following differences in financial patterns between small and young firms with respect their bigger counterparts. The smaller the firm, the more total leverage it has (fact 1) and the more bank dependent is (fact 2). If there is a general decrease of other leverage, smaller firms cannot substitute it with bank leverage and end deleveraging during the crisis (fact 3). Moreover, as fact 2 also shows, bank leverage has low volatility for smaller firms, indicating that for these firms bank leverage is not flexible and cannot be used easily to accommodate shocks. Section 1.2.2 demonstrates that some of these effects are amplified if firms are younger. The younger the firm, the more total leverage (fact 6), the more bank dependent (fact 7), and the most it had to deleverage during the crisis (facts 6 and 7). But do these effects make a firm more vulnerable? I will test in section 1.3 if these facts have real effects' implications.

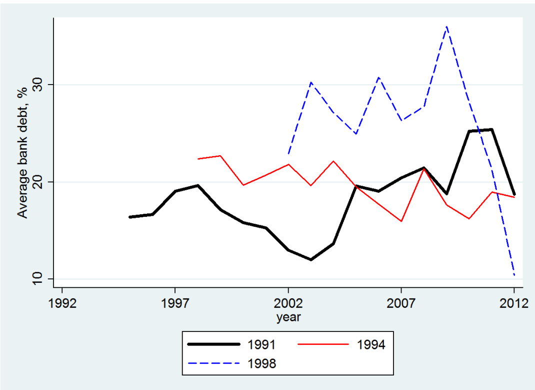


Figure 18: Bank leverage. 1991 vs 1994 vs 1998

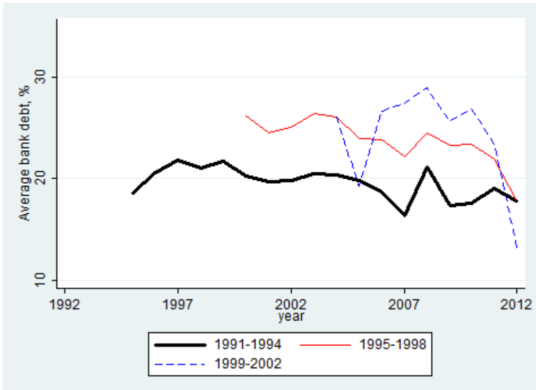


Figure 19: Bank leverage. 91-94 vs 95-98 vs 99-02

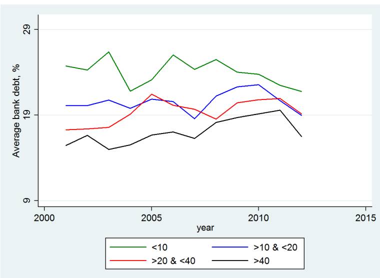


Figure 20: Bank leverage. Small firms. Cohort comparison

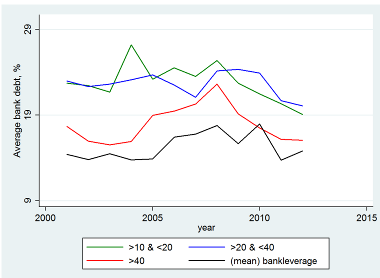


Figure 21: Bank leverage. Medium firms. Cohort comparison

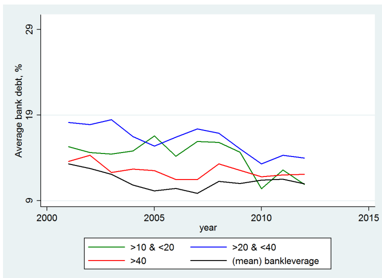


Figure 22: Bank leverage. Big firms. Cohort comparison

1.3 Job destruction, investment drops and financial patterns

Section 1.2 concluded that small and young firms at the beginning of the crisis had more total leverage, more bank leverage and they had to deleverage more during the crisis years. In this section I estimate the effects of these patterns on job destruction and on investment. On the one hand, I estimate the effects on job destruction and investment of being attached to bank leverage. On the other hand, I estimate the effects on job destruction and investment of deleveraging. For job destruction results are in section 1.3.1 and for investment in section 1.3.2.

There are potential problems regarding the regressions that I propose. First of all, my data consists on a small number of time periods, 20, and a large number of observations per year, around 2000. Secondly, the observations include fixed effects across time. Each firm is expected to have an unobservable component, fixed during time, affecting variables of interest. Also, both variables of interest, employment and investment, are dynamic since they depend on their own past realizations. Last, most of my controls are not strictly exogenous, since they could be correlated with present and past realizations of the error. I deal with these problems one by one. The original regression is:

$$Y_{i,t} = \beta_0 + \beta_1 Y_{i,t-1} + \beta_2 X_{i,t} + u_{i,t}, \qquad u_{i,t} = v_{i,t} + \epsilon_i \quad (1)$$

where $Y_{i,t}$ is the dependent variable, either employment growth or investment growth, $X_{i,t}$ are the independent variables among which there would be a comprehensive set of controls, $Y_{i,t-1}$ is the lagged dependent variable, and $u_{i,t}$ is the error term which includes fixed effect ϵ_i. This fixed effect component captures unobserved heterogeneity across firms. I assume that it is correlated with time variant regressors, i.e. $\mathbb{E}[X_{i,t}\epsilon_i] \neq 0$, $\mathbb{E}[Y_{i,t-1}\epsilon_i] \neq 0$. In order to avoid this problem, I take first difference over equation (1), yielding equation (2)

$$\Delta Y_{i,t} = \beta_1 \Delta Y_{i,t-1} + \beta_2 \Delta X_{i,t} + \Delta u_{i,t} \quad (2)$$

Despite the fact that I have got rid of the fixed effects problem, a new issue arises. The new error term $\Delta u_{i,t} = u_{i,t} - u_{i,t-1}$ is correlated with regressors $\Delta Y_{i,t-1} = Y_{i,t-1} - Y_{i,t-2}$ since it is obvious that $\mathbb{E}[Y_{i,t-1}u_{i,t-1}] \neq 0$. Then $\Delta Y_{i,t-1}$ is an endogenous regressor. One solution could be use lagged values in levels of the endogenous regressors as instruments. This is the proposal of the difference GMM estimator by Arellano and Bond (1991), who transform the original regression by taking first differences and use generalized method of moments with lagged regressors in levels as instruments. This method could be misguiding if some regressors follow a high order autoregressive process, since lagged levels could be weak instruments for differentiated variables. In my data some of the variables are highly autocorrelated, like investment, size or sales. A way to solve this problem is using the system GMM estimator proposed by Blundell-Bond (1995). System GMM estimator uses the original equation in levels and the original equation in differences. It considers lagged regressors in differences as instruments for the level equation, and lagged regressors in levels as instruments for the differentiated equation. This way more instruments can be used than in the difference GMM estimator. In order to use lagged regressors in differences as instruments, I need to assume that first differences of instrument variables are not correlated with fixed effects. Let's denote potential instrumental variables by z_t. The additional assumption needed to perform system GMM is that $\mathbb{E}(\Delta z_{i,t}\epsilon_i) = 0$, which implies that $\mathbb{E}(z_{i,t}\epsilon_i)$ is time invariant. System GMM estimator solves all the potential problems I commented above.

I take into consideration possible autocorrelation of errors when choosing lags of instruments variables. If u_t is autocorrelated with u_{t-2}, then I should use Δz_{t-3} as instrument for the level equation (1) and z_{t-3} as instrument for the differentiated equation (2). If u_t is autocorrelated with u_{t-3}, then I need to use higher lags of Δz_t and z_t. For each regression I specify clearly which set of instruments I am using. In the appendix I present both autocorrelation test and Hansen tests for each of the regressions. Also, in appendix I show the relevance test for the set of instruments. I am cautious about claiming causality. Most regressors included in the set of controls $X_{i,t}$ are clearly endogenous variables. I instrument the endogenous variables in $X_{i,t}$ in the same way that I instrumented for $\Delta Y_{i,t-1}$ in the difference equation and for $Y_{i,t-1}$ in the level equation. However, the aim of this work is not claiming causality; I am interested in the size and the direction of the effect on job destruction and investment.

1.3.1 Bank leverage and job destruction

In this section I test the effect of bank leverage on employment growth. How can bank leverage affect job destruction? Recall the bank lending channel by Bernanke and Blinder (1989). If there is a credit crunch, the bank dependent borrowers will not be able to compensate bank credit by other kind of credit due to the financial restrictions. Therefore they would have to cut expenses like employment or investment. I determine if bank leverage and other leverage had a significant negative effect on job destruction either during normal times or during a credit crunch. I consider two credit crunch periods in the sample by looking at figure 23, built from data of Banco de España. This figure shows the variation of credit from banks to industries from 1991 onwards. The first credit crunch period is composed by years from 1992 to 1994. The second one is formed by years from 2008 and 2012. In that figure it can be seen that by 2008 the increments of bank credit were already slowing down. At the end of 2008, for the first time since November 1996, there are two consecutive trimesters with less than 1% of growth of credit. Since then, most trimesters have experimented a negative growth of credit.

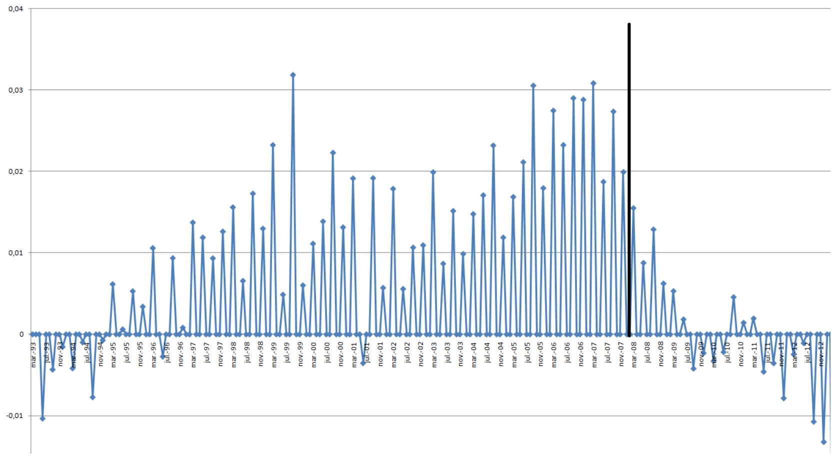


Figure 23: Variation of credit from financial institutions to nonfinancial institutions

The regression I propose is:

$$\begin{aligned}\Delta Emp_{i,t} = \beta_0 + \beta_1 \Delta Emp_{i,t-1} + \beta_2 BankLeverage_{i,t} + \beta_3 OtherLeverage_{i,t} \\ +\beta_4 BankLeverage_{i,t} * Crunch92_{i,t} + \beta_5 OtherLeverage_{i,t} * Crunch92_{i,t} \\ +\beta_6 BankLeverage_{i,t} * Crunch08_{i,t} + \beta_7 OtherLeverage_{i,t} * Crunch08_{i,t} \\ +\beta_8 X_{i,t} + \beta_9 Time_t + \beta_{10} Industry_i + \beta_{11} c_i + \varepsilon_{i,t} \qquad \textbf{(3)} \text{ s}\end{aligned}$$

where BankLeverage, OtherLeverage and their interactions with the dummy variables regarding the crunch periods are the variables of interest. The dependent variable is growth rate of employment, $\Delta Emp_{i,t} = employment_{i,t} - employment_{i,t-1}$. Crunch92 is a dummy variable that takes value one if the period is 1992, 1993 or 1994 and zero otherwise. Crunch08 is a dummy variable that takes value one if the period is 2008, 2009, 2010, 2011 or 2012, and zero otherwise. c_i accounts for the unobserved fixed effects at firm level, and ε is a standard error. Variable X contains the controls. I include as controls current assets ratio, sales, age of the firm, age squared and asset size. All independent variables include contemporaneous values and one lag value. Variable Industry includes 19 dummies to account for the

20 industries[9]. Variable Time includes 20 time dummies to account for the period 1991-2012.

I perform the system GMM estimation of regression 3 for the total sample, and for subsamples with small firms, medium firms and big firms. Each result is in a different column. The total sample and the subsamples for medium and big firms display autocorrelation of order 1 in the errors. In these samples, for the level equation I use as instruments lags 2 to 4 of $\Delta(\Delta(Emp_{t-1}))$ and of ΔX_{t-1}. And for the difference equation I use as instruments lags 2 to 4 of $\Delta(Emp_{t-1})$ and of X_{t-1}. The sample for small firms displays weak autocorrelation of order 2 in the errors, so I use lags 3 to 5 of $\Delta(\Delta(Emp_{t-1}))$ and of ΔX_{t-1} as instruments for the level equation. And for the difference equation I use as instruments lags 3 to 5 of $\Delta(Emp_{t-1})$ and of X_{t-1}[10]. Dummies for year and industry, and variables regarding age are considered exogenous. For all the regressions, I display autocorrelation tests and Hansen tests[11].

The results of the system GMM regression of 3 are in table 3. Four important lessons can be driven from this table: First of all, being attached to bank leverage during normal times does not imply a negative effect on employment growth. Variable BankLeverage$_{i,t}$ is not significant for employment growth for any of the subsamples. Secondly, being attached to bank leverage during last credit crunch supposes a strong negative effect on employment growth for small and medium firms, while bank attachment has no significance on employment growth for big firms. The interaction of BankLeverage and Crunch08 has a significant effect at 1% for total sample, small and medium firms, and its value is negative. An increase of 1% of bank debt during the crunch period can decrease employment growth around 0.17% and 0.2%. Third, during the credit crunch, other leverage has smaller negative effect on employment growth and is less significant than bank leverage. Other leverage is slightly significant during normal times, but only for small firms. During the credit crunch, other leverage turns significant and negative for total sample and medium firms, but is only significant at 10% and its effect is lower than the effect of bank leverage during credit crunch, $\hat{\beta_7} = -0.0978, -0.144$ while $\hat{\beta_6} = -0.168, -0.199$ for total sample and

[9] In appendix I indicate which are the 20 manufacturing industries included.

[10] The choice of different lags for small firms' subsample is not relevant for the results. Since the autocorrelation of order 2 is weak, I perform a robustness check using the same instruments as with the other subsamples and the result do not change.

[11] The autocorrelation tests indicates me which lags of the instrument variables should I use. I show the autocorrelation test up to order 3. The null hypothesis of an autocorrelation test of order i is that the error term of the regression displays autocorrelation of order i. The Hansen test assesses the validity of the over identifying restrictions, under the null hypothesis that overidentification restrictions are valid, For both tests, I present the statistics and the p value associated with the null hypothesis in parenthesis.

medium size firms respectively. And fourth, credit crunch from 1992 does not have a special impact on the effect of bank leverage on employment growth. It can be seen that the interaction of BankLeverage and Crunch92 is not significant for any of the subsamples.

1.3.2 Deleveraging and job destruction

Now I test the effect of deleveraging on employment growth. How can deleverage affect real variables? If a household or a firm experiments a cut in her income, she will have to cut expenditures unless she is able to borrow. In our context of manufacturing firms in Spain, if a given firm experiments a decrease in sales and it is not able to borrow, it will end up cutting expenditures. In this section I test if deleveraging has an effect in job destruction either during normal times or during a sales crunch. First I define the sales crunch period. Figure 24 shows growth of sales for small (blue line), medium (red line) and big firms (black line) from 1991 to 2012. It is built from the sample that ESEE provides. It can be seen that the years in which sales went down severely were 2008 and 2009. I consider those years as the sales crunch period.

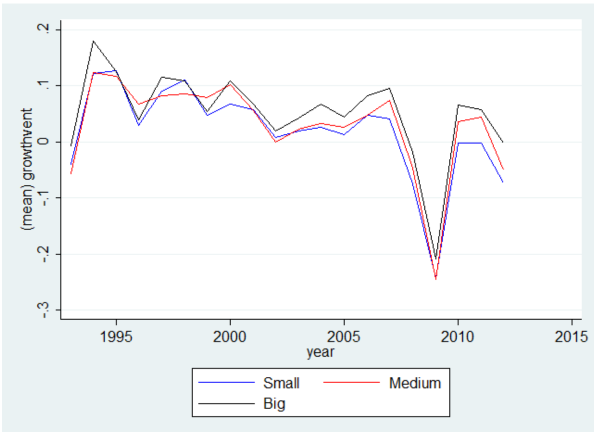


Figure 24: Growth of sales

The regression I propose is:

$$\Delta Emp_{i,t} = \beta_0 + \beta_1 \Delta Emp_{i,t-1} + \beta_2 \Delta Tot_{i,t} + \beta_3 Totalleverage_{i,t} + \beta_4 \Delta Tot_{i,t} * Crunch08 + \beta_5 Totalleverage_{i,t} * Crunch08 + \beta_6 X_{i,t} + \beta_{Time} Time + \beta_{Industry} Industry + \beta_5 c_i + \varepsilon_{i,t} \quad \textbf{(4)}$$

where $\Delta Tot = TotalLeverage_t - TotalLeverage_{t-1}$ and its interactions with the dummy variable regarding the crunch periods are the variables of interest. Crunch08 is a dummy variable that is one if

	(1) Total sample $\Delta Emp_{i,t}$	(2) Small firms sample $\Delta Emp_{i,t}$	(3) Medium firms sample $\Delta Emp_{i,t}$	(4) Big firms sample $\Delta Emp_{i,t}$
BankLeverage$_{i,t}$	**.0288**	**-0.108**	**0.0708**	**0.0691**
	(0.1008)	**(0.0980)**	**(0.1039)**	**(0.1334)**
OtherLeverage$_{i,t}$	**-.2033**	**-0.152***	**-0.0349**	**-0.0597**
	(0.0830)	**(0.0883)**	**(0.0921)**	**(-0.1102)**
BankLeverage*Crunch08$_{i,t}$	**-.1700*****	**-0.189*****	**-0.199*****	**-0.0463**
	(0.0452)	**(0.0743)**	**(0.0782)**	**(-0.0804)**
OtherLeverage*Crunch08$_{i,t}$	**-.0947****	**-0.0316**	**-0.144***	**-0.0477**
	(0.0463)	**(0.0584)**	**(0.0862)**	**(-0.0661)**
BankLeverage*Crunch92$_{i,t}$	**.00786**	**-0.0169**	**0.0597**	**0.0234**
	(0.0694)	**(0.1041)**	**(0.1438)**	**(0.1243)**
OtherLeverage*Crunch92$_{i,t}$	**-.09873**	**-0.239**	**-0.187**	**0.0522**
	(0.1228)	**(0.2917)**	**(0.1248)**	**(0.0739)**
$\Delta Emp_{i,t-1}$	-.07118**	-0.314***	-0.148**	-0.0820*
	(0.0356)	(0.0560)	(0.0479)	(0.0342)
Current assets $ratio_{i,t}$	-.05492	-0.105*	0.0994	0.0123
	(0.0676)	(0.0562)	(0.0707)	(0.0883)
$Size_{i,t}$	13.2155***	3.117	1.665	26.83***
	(3.7581)	(3.1808)	(4.2396)	(5.5888)
$Sales_{i,t}$	25.4005***	22.51***	22.20***	17.48***
	(4.6615)	(3.9372)	(6.2322)	(4.3290)
$Age_{i,t}$	-.2028***	-0.165***	-0.140***	-0.0868***
	(0.0395)	(0.0399)	(0.0437)	(0.0227)
$Age^2_{i,t}$	.00095***	0.00102**	0.000845***	0.000282**
	(0.0023)	(0.0003)	(0.0003)	(0.0001)
Standard errors in parentheses				
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$				
Observations	24956	10420	6465	6248
Year fixed effects	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES
Method	System GMM	System GMM	System GMM	System GMM
Autocorrelation test. Order 1	-5.31***	-5.76***	-6.73***	-2.46**
	(0.000)	(0.00)	(0.00)	(0.014)
Autocorrelation test. Order 2	-0.68	-2.4**	-0.2	-0.88
	(0.49)	(0.016)	(0.84)	(0.38)
Autocorrelation test. Order 2	-	-0.1	-	-
	-	(0.91)	-	-
Hansen test	517.26*	382.14	431.36	411.32
	(0.057)	(0.38)	(0.107)	(0.28)
p value in parentheses				
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$				

Table 3: System GMM estimation of regression 3

the period is 2008 or 2009 and zero otherwise. c_i accounts for the unobserved fixed effects at firm level, and ε is a standard error. The dependent variable is growth rate of employment. Variable X contains the controls. Controls are current assets ratio, growth of sales, age of the firm, age squared, asset size and total leverage. All independent variables include contemporaneous and one lag values. Dummies Industry and Time are the same as in regression 3. This time, all samples (total, small firms, medium firms and big firms) display autocorrelation of order 1 in the errors. Therefore for the level equation I use as instruments lags 2 to 4 of $\Delta(\Delta(Emp_{t-1}))$ and of ΔX_{t-1}. And for the difference equation I use as instruments lags 2 to 4 of $\Delta(Emp_{t-1})$ and of X_{t-1}. Dummies for year and industry, and variables regarding age are considered exogenous.

Results of the GMM estimation of regression 4 are in table 4 [12]. The variables of interest are growth of total leverage, $\Delta Tot_{i,t}$, and its interaction with the crunch sales variable, $\Delta Tot_{i,t} * Crunch08_{i,t}$. From all columns it can be seen that the growth of total leverage is never significant for employment growth for any of the samples analyzed. However, the interaction of growth of total leverage with the years of the sales crunch (2008, 2009) is significant at 5% and positive for small firms, $\hat{\beta}_3 = 0.165$. The fact that is positive indicates that, the bigger the deleverage process faced by small firms, the more negative effect on employment. On the other hand, growth of total leverage does not seem to have a significant effect for the rest of the firms even during the sales crunch periods. Two main results can be derived from this regression. First, deleveraging during normal periods does not have an effect on employment growth. Secondly, deleveraging during a sales crunch period has a negative effect on employment growth for small firms, but not for the rest of firms.

1.3.3 Bank leverage and investment drops

In this section I analyze the effect of bank leverage on investment growth. I do not focus on credit crunch periods like I did when estimating the real effects on job destruction. Employment and investment time series have different patterns. Average investment follows higher peaks and lower downs than average employment, its variance is bigger. That fact is well represented in figure 25, where I present average growth of employment (black) and average growth of investment (red). Downs in average investment in 1992-1993 are about 20%, in 2000-2001 are also about 20%, and in 2009 there was a decrease of almost

[12] In table 4 I drop top 0.5 and lowest 0.5 centile of growth of total leverage to get rid of extreme values.

	(1) Total sample $\Delta Emp_{i,t}$	(2) Small firms sample $\Delta Emp_{i,t}$	(3) Medium firms sample $\Delta Emp_{i,t}$	(4) Big firms sample $\Delta Emp_{i,t}$
Δ Tot$_{i,t}$	**0.0390**	**-0.0409**	**-0.0107**	**0.0573**
	(0.0402)	**(0.0259)**	**(0.0594)**	**(0.0507)**
Total leverage$_{i,t}$	**-0.241***	**-0.0565**	**-0.0249**	**-0.141**
	(0.1362)	**(0.1066)**	**(0.1556)**	**(0.1439)**
Δ Tot$_{i,t}$***Crunch08**$_{i,t}$	**-0.0234**	**0.165****	**-0.101**	**-0.0331**
	(0.1064)	**(0.0805)**	**(-0.2012)**	**(0.1141)**
Total leverage$_{i,t}$***Crunch08**$_{i,t}$	**-0.0979*****	**-0.0787***	**-0.0957**	**-0.0789***
	(0.0273)	**(0.0406)**	**(0.0580)**	**(0.0438)**
$\Delta Emp_{i,t-1}$	-0.0442	-0.163***	-0.115***	-0.0989***
	(0.0371)	(0.0610)	(0.0485)	(0.0347)
Current assets $ratio_{i,t}$	-0.0800	-0.0728	0.0814	0.000390
	(0.0650)	(0.0612)	(0.0696)	(0.0390)
$Size_{i,t}$	12.65***	7.730**	6.929*	21.08***
	(4.3772)	(3.8458)	(3.9147)	(4.8128)
$Sales_{i,t}$	31.36***	19.58***	18.42***	36.80***
	(4.1925)	(4.6842)	(6.0393)	(4.9132)
$Age_{i,t}$	-0.198***	-0.173***	-0.119***	-0.0630***
	(0.0406)	(0.0347)	(0.0402)	(0.0234)
$Age^2_{i,t}$	0.000907***	0.00105***	0.000704***	0.000211
	(0.0002)	(0.0002)	(0.0002)	(0.0001)
Standard errors in parentheses				
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$				
Observations	24311	10117	6344	6122
Year fixed effects	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES
Method	System GMM	System GMM	System GMM	System GMM
Autocorrelation test. Order 1	-8.89***	-7.42***	-6.94***	-7.33***
	(0.00)	(0.00)	(0.00)	(0.00)
Autocorrelation test. Order 2	-4.26***	-4.16***	-2.83***	-3.07***
	(0.00)	(0.00)	(0.00)	(0.00)
Autocorrelation test. Order 3	1.26	0.82	0.059	1.93*
	(0.16)	(0.41)	(0.55)	(0.054)
Hansen test	376.59	37.21	368.58	345.22
	(0.49)	(0.57)	(0.61)	(0.87)
p value in parentheses				
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$				

Table 4: System GMM estimation of regression 4

40%. By contrast, drops for growth employment are much milder, not even 10% during the recent crisis. I consider an investment crunch those periods in which there were simultaneously investment drops and credit crunch, i.e 1992-1993 and 2009. I use dummy variables to capture the effect of the variables of interest during these periods.

Figure 25: Growth of employment. Growth of investment

The regression I propose in levels is:

$$\begin{aligned}\Delta Invest_{i,t} = \beta_0 + \beta_2 \Delta Invest_{i,t-1} + \beta_2 BankLeverage_{i,t} + \beta_3 OtherLeverage_{i,t} \\ +\beta_4 BankLeverage * Crunch92_{i,t} + \beta_5 OtherLeverage * Crunch92_{i,t} \\ +\beta_6 BankLeverage * Crunch09_{i,t} + \beta_7 OtherLeverage * Crunch09_{i,t} \\ +\beta_8 X_{i,t} + \beta_{Time} Time + \beta_{Industry} Industry + \beta_9 c_i + \varepsilon_{i,t} \qquad \textbf{(5)}\end{aligned}$$

where BankLeverage, OtherLeverage and their interactions with the dummy variables regarding the investment crunch periods are the variables of interest. Dependent variable is $\Delta Invest_{i,t}$ =Investment $rate_t$−Investment $rate_{t-1}$. Variable Crunch92 is a dummy variable that is one if the period is 1992 or 1993 and zero otherwise. Crunch09 is a dummy variable that takes value one if the period is 2009 and zero otherwise. c_i accounts for the unobserved fixed effects at firm level, and ε is a standard error. Variable X contains the controls. I include the same controls as before: current assets ratio, growth of sales, age of the firm, age squared and asset size. This time, all samples (total, small firms, medium firms and big firms) display autocorrelation of order 2 in the errors. Therefore for the level equation I use as instruments lags 3 to 5 of $\Delta(\Delta(Emp_{t-1}))$ and of ΔX_{t-1}. And for the difference equation I use as instruments lags 3 to 5 of $\Delta(Emp_{t-1})$ and of X_{t-1}. Dummies for year and industry, and variables regarding age are considered exogenous.

Results of the GMM estimation of regression 5 are in table 5. I highlight three results. First, being attached to bank leverage during normal times does not imply a negative effect on investment growth. Variable BankLeverage is not significant for employment growth for any of the subsamples. Secondly, being attached to bank leverage during last credit crunch supposes a strong negative effect on investment growth only for medium firms, while bank attachment has no significance on investment growth for small and big firms. The interaction of BankLeverage and Crunch09 has a significant effect at 5% for medium firms, and its value is negative. An increase of 1% of bank debt during the crunch period can decreases investment growth around 1.4 %. Third, during the credit crunch, other leverage has a positive and significant effect on investment growth. Other leverage is never significant during normal times, but during the credit crunch, other leverage turns significant and positive for small and medium firms. It is significant at 1% and 5% respectively. This is an interesting result. While being attached to bank leverage during a credit crunch is associated with lower investment growth, for small and medium firms the more access to other leverage, the more investment growth. And fourth, credit crunch from 1992 does not have a special impact on the effect of bank leverage on investment growth. It can be seen that the interaction of BankLeverage and Crunch92 is not significant for any of the subsamples.

1.3.4 Deleveraging and investment drops

In section 1.3.2 I showed that deleveraging has a significant negative effect on employment growth. In this section I try to asses if deleveraging has a significant effect on investment growth during the investment drop periods.

The regression I propose is:

$$\Delta Invest_{i,t} = \beta_0 + \beta_1 \Delta Invest_{i,t-1} + \beta_2 \Delta Tot_{i,t} + \beta_3 \Delta Tot_{i,t} * Crunch09_{i,t} + \beta_4 X_{i,t} + \beta_{Time} Time + \beta_{Industry} Industry + \beta_5 c_i + \varepsilon_{i,t} \qquad \textbf{(5)}$$

where all variables are the same as in section 1.3.3 except the dummy variable, that now is Crunch09, a dummy variable equal to one if period is equal to 2009, and zero otherwise. Total sample and medium firms' sample display autocorrelation of order 2 in the errors. Therefore for the level equation I use as instruments lags 3 to 5 of $\Delta(\Delta(Emp_{t-1}))$ and of ΔX_{t-1}. And for the difference equation I use as instruments lags 3 to 5 of $\Delta(Emp_{t-1})$ and of X_{t-1}. The sample for small firms and big firms display autocorrelation of order 1 in the errors, so I use lags 2 to 4 of $\Delta(\Delta(Emp_{t-1}))$ and of ΔX_{t-1} as instruments for the level equation. And for the difference equation I use as instruments lags 2 to 4 of

	(1) Total sample $\Delta Invest_{i,t}$	(2) Small firms sample $\Delta Invest_{i,t}$	(3) Medium firms sample $\Delta Invest_{i,t}$	(4) Big firms sample $\Delta Invest_{i,t}$
BankLeverage$_{i,t}$	**-0.320**	**-0.119**	**0.679**	**0.945**
	(0.7064)	**(0.9180)**	**(0.6587)**	**(0.6967)**
OtherLeverage$_{i,t}$	**-0.609**	**0.689**	**0.0908**	**0.385**
	(0.6396)	**(0.9197)**	**(0.5907)**	**(0.4948)**
BankLeverage*Crunch09$_{i,t}$	**-0.527**	**0.0942**	**-1.405****	**-0.143**
	(0.4804)	**(0.8464)**	**(0.5907)**	**(0.6857)**
OtherLeverage*Crunch09$_{i,t}$	**1.200*****	**3.851*****	**1.360****	**-0.177**
	(0.4462)	**(1.2195)**	**(0.6455)**	**(0.4668)**
BankLeverage*Crunch92$_{i,t}$	**0.660**	**0.707**	**0.534**	**0.347**
	(0.4622)	**(0.8240)**	**(0.7723)**	**(0.7506)**
OtherLeverage*Crunch92$_{i,t}$	**-0.0500**	**0.365**	**1.362**	**-1.747***
	(0.5955)	**(1.1142)**	**(1.0788)**	**(0.9184)**
$\Delta Invest_{i,t-1}$	-0.433***	-0.612***	-0.485***	-0.439***
	(0.0428)	(0.0424)	(0.0458)	(0.0459)
Current assets $ratio_{i,t}$	-2.179***	-3.103***	-0.497	-0.746***
	(0.4413)	(0.5567)	(0.4529)	(0.3966)
$Size_{i,t}$	57.46**	80.33***	0.857	37.00*
	(26.2651)	(33.1524)	(21.7476)	(21.2441)
$Sales_{i,t}$	-5.096	5.506	3.005	-36.62
	(26.7757)	(32.7512)	(24.5618)	(25.7460)
$Age_{i,t}$	0.211	0.897***	0.170	0.109
	(0.2092)	(0.3364)	(0.2164)	(0.0961)
$Age2_{i,t}$	-0.00161	-0.00683***	-0.000931	-0.000882
	(0.0010)	(0.00252)	(0.0014)	(0.0005)
Standard errors in parentheses				
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$				
Observations	24311	10117	6344	6122
Year fixed effects	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES
Method	System GMM	System GMM	System GMM	System GMM
Autocorrelation test. Order 1	-5.57***	-6.85***	-7.59***	-2.41**
	(0.00)	(-2.67)	(0.008)	(0.016)
Autocorrelation test. Order 2	1.58	-1.09	-0.21	0.06
	(0.11)	(0.27)	(0.83)	(0.95)
Hansen test	432.59*	429.59*	420.62	419.21
	(0.063)	(0.076)	(0.13)	(0.14)
p value in parentheses				
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$				

Table 5: System GMM estimation of regression 5

$\Delta(Emp_{t-1})$ and of X_{t-1}. Dummies for year and industry, and variables regarding age are considered exogenous.

Results of the GMM estimation of regression 6 are in table 6. I highlight two results from regression 6. First of all, growth of total leverage and its interaction with the dummy crunch are only significant for small firms. For the rest of the subsamples, both $\Delta TotalLeverage$ and $\Delta TotalLeverage * Crunch09$ are never significant. Secondly, for small firms, the effect of growth of total leverage over investment growth changes with the crunch. During normal times, $\Delta TotalLeverage$ is significant at 1% and has a negative effect on investment growth, meaning that deleveraging implies a higher investment growth. However, during sales and investment crunch period, deleveraging has a negative effect on investment growth. This effect is significant only at 10%. To recap, from regression 4 and 6 I conclude that deleveraging affects employment and investment decisions only for small firms, and only during the years 2008 and 2009 (during the sales crunch).

1.4 Conclusions

The aim of this paper is assessing if the financial structure of small and young firms had a negative effect on their employment and investment decisions during the last financial crisis. In order to answer that question I follow two steps. First I document differences in the financial structure between small and young firms and their bigger and older counterparts. Secondly, I test if these differences matter when firms undertook employment and investment decisions during the last crisis.

In the first part I provide stylized facts from a cross sectional analysis and from a life cycle analysis about financial patterns. The main conclusions from both analysis are that smaller and younger firms at the beginning of the crisis had more total leverage, more bank dependency and had to deleverage more during the crisis years. Small firms were unable to keep leverage constant, and were also unable to interchange bank leverage by other type of leverage at early crisis years. In the second part, I test the effects of bank dependency and deleverage on job destruction and investment. I find that bank leverage affects negatively employment growth only for small and medium firms and only during recent credit crunch. But bank leverage had a strong and negative effect on investment only during the investment crunch of 2009, and it was significant only for medium firms. On the other hand, I estimate the effects on job destruction and investment on deleveraging. I find that deleveraging has a significant negative

	(1) Total Sample $\Delta Invest_{i,t}$	(2) Small firms sample $\Delta Invest_{i,t}$	(3) Medium firms sample $\Delta Invest_{i,t}$	(4) Big firms sample $\Delta Invest_{i,t}$
Δ TotalLeverage$_{i,t}$	**-0.00328**	**-0.00606*****	**0.00312**	**-0.000209**
	(0.0025)	**(0.0020)**	**(0.0038)**	**(0.0025)**
TotalLeverage$_{i,t}$	**0.00801**	**0.0211*****	**-0.00236**	**0.00173**
	(0.0083)	**(0.0090)**	**(0.0110)**	**(0.0078)**
Δ TotalLeverage$_{i,t}$*Crunch09$_{i,t}$	**0.0158****	**0.0178***	**0.00349**	**0.00336**
	(0.0088)	**(0.0094)**	**(0.0078)**	**(0.0053)**
TotalLeverage$_{i,t}$*Crunch09$_{i,t}$	**0.00316**	**0.0148****	**-0.000950**	**-0.000521**
	(0.0042)	**(0.0065)**	**(0.0055)**	**(0.0044)**
$\Delta Invest_{i,t-1}$	-0.388***	-0.560***	-0.539***	-0.465***
	(0.0512)	(0.0416)	(0.0494)	(0.0477)
Current assets $_{i,t}$	-0.0204***	-0.0211***	-0.00592	-0.00408
	(0.0046)	(0.0055)	(0.0044)	(0.0036)
$Size_t$	0.648***	1.078***	0.310	0.333*
	(0.2605)	(0.3269)	(0.2196)	(0.1767)
$Sales_t$	-0.546**	-0.276	-0.194	-0.367*
	(0.2683)	(0.3486)	(0.2555)	(0.2230)
$Age_{i,t}$	-0.000230	0.00318	0.000201	0.000899
	(0.0021)	(0.0031)	(0.0023)	(0.0009)
$Age^2_{i,t}$	-0.00000107	-0.0000363	0.00000328	-0.000007
	(0.00001)	(0.00002)	(0.00001)	(0.000004)
Standard errors in parentheses				
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$				
Observations	24311	10117	6344	6122
Year fixed effects	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES
Method	System GMM	System GMM	System GMM	System GMM
Autocorrelation test. Order 1	-6.98***	-8.95***	-6.16***	-7.93***
	(0.00)	(0.00)	(0)	(0.00)
Autocorrelation test. Order 2	-1.92*	-1.43	-3.74***	-0.84
	(0.057)	(0.15)	(0.00)	(0.40)
Autocorrelation test. Order 3	-1.08	-	1.14	-
	(0.27)	-	(0.25)	-
Hansen test	318.65	424.65	357.98	380.96
	(0.842)	(0.14)	(0.67)	(0.685)
p value in parentheses				
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$				

Table 6: System GMM estimation of regression 6

effect on employment growth only during sales crunch for small firms. And deleveraging has significant positive effect on investment growth during normal times but becomes negative during sales crunch.
This paper contributes to several strands of the literature. First of all, it contributes to the financial empirical literature. There is a lack of micro data empirical work about leveraging patterns of non-financial firms, especially during the last financial crisis, and I hope to contribute to it with this paper. Also, in the empirical literature little effort has been done to document the behavior of bank leverage vs other leverage in non financial firms. Secondly, I contribute to the literature of firms' financing life cycle. To the best of my knowledge, this is the first paper to compare the financial behavior of different cohorts during the recent crisis. Lastly, this paper presents two novel strategies to assess the effects on employment and investment of the recent credit crunch. Specifically, I quantify the effect on job destruction/investment growth of bank and other leverage, and of deleveraging.
A promising future work could be a similar cross sectional and life cycle analysis, but using data from another countries. This way cross country differences could be studied. Also, it would be very relevant to divide other leverage into several subcategories. In this paper I only differentiate between bank and other leverage, but other leverage could be divided itself in different categories.

1.5 Appendix

1.5.1 Definition of variables

Total leverage: It is a % computed as liabilities (amount of obligations/credits of the firm), divided by liabilities and amount of owner's equity. I distinguish between Bank leverage and Other leverage.
Total leverage = Bank leverage + Other leverage
Bank leverage: It is a % computed as amount of credit owned to financial institutions divided by total leverage. Includes short (to pay in less than a year) and long (to pay in a year) credit
Other leverage: It is a % computed as amount of non financial credit divided by total leverage. It includes short and long credit. Other leverage is composed by suppliers, other creditors, advanced payments from clients, pending personal payments, loans from public administrations, anticipated revenue, operating allowances, debt securities and other similar liabilities, debts with own group companies, debt from non financial companies , other non-financial accounts and interest collected in advance.
Sales growth: Log growth of sales.

Employment: Total number of employees.

Investment: It is computed as acquisitions and reparations of equipment, industrial machinery, furniture and fixed capital over sales.

Temporal employment: % of temporal workers over total workers

Age: Current year minus the year of foundation

Size: Logarithm of total assets.

Current assets: % of current assets over total assets

Credit crunch: Periods from 1992 to 1994, and from 2008 to 2012

Investment crunch: Periods from 1992 to 1994, and from 2008 to 2009

Sales crunch: Periods from 2008 to 2009

Industries

There are 20 possible manufacturing industries in Spain

1. Meat industry
2. Food products and tobacco
3. Beverages
4. Textiles
5. Leather and shoes
6. Wood
7. Paper industry
8. Printing
9. Chemicals and pharmaceutics
10. Rubber and plastic
11. Non metallic minerals
12. Ferrous metals
13. Metal products
14. Agricultural and industrial machinery
15. Computer, electronic and optical product
16. Electric machinery and equipment
17. Motor vehicles
18. Other transport equipment
19. Furniture

20. Other manufacturing services

1.5.2 Relevance tests

In table 7 I show the relevance test for the instruments of the difference regression, and in table 8 I show the relevance test for the instruments of the level regression. Each column contains an OLS regression of an endogenous regressor as a function of the instruments variables. At the bottom of those tables it can be seen the following information: the number of observations, the R squared, and the F statistic and the p value associated with the null hypothesis that instruments are not jointly significant. In all regressions, the null hypotheses that instruments are not jointly significant are rejected.

1.5.3 Vulnerability and Schumpeter

Who is more vulnerable at the onset of a crisis? According to Schumpeter, the most vulnerable firms are the old and nonproductive firms. As I mentioned in the introduction, in his work *Capitalism, Socialism and Democracy (1942)* he stated that at the onset of an economic crisis old nonproductive firms should be expected to be more vulnerable, and consequently substituted by new and productive firms. But is this happening? Looking at data from Spain during the recent financial turmoil, such a conclusion does not seem accurate. I present three figures that refute that idea. In figure 26b I present the productivity of manufacturing firms above 10 employees from 1991 to 2012 in Spain. Productivity is measured as Euros by employee. Figure 26b shows that productivity did not increase in the sample during the crisis. It grew at a high rhythm from 1991 until 2000, it stagnated until 2008, and went down afterward, specially in 2009. Although it has grown a bit since then, productivity of Spanish manufacturing firms is lower in 2012 than in 2007. According to Schumpeter, it should be expected that thanks to the creative destruction, nonproductive firms would have disappeared leaving room for new productive firms. Consequently total productivity of the economy should have risen during crisis, but this is not the case. Figure 26a shows the distribution of productivity in 2007 (black line) and in 2012 (red line). Productivity is also measured in Euros per employee. After reading Schumpeter conclusions, it should be expected that the left tail of 2012's distribution of productivity should be smaller than the left tail of 2007's distribution. This should be the case if nonproductive firms had disappeared at a higher rhythm during the crisis. However, both distributions look almost the same. If anything, the distribution in 2012 has a left tail bigger than the 2007 one, and distribution in 2012 is slightly

	(1) $\Delta(\Delta Emp_{i,t-1})$	(2) Δ Current assets $_{i,t}$	(3) $\Delta Size_t$	(4) $\Delta Sales_t$	(5) $\Delta BankLeverage_t$	(6) $\Delta OtherLeverage_t$
$\Delta Emp_{i,t-3}$	0.127**	0.00642	0.000506***	0.000264	0.0116*	-0.000724
	(0.0564)	(0.0068)	(0.00016)	(0.00022)	(0.0059)	(0.0071)
$\Delta Emp_{i,t-4}$	0.0558***	0.00314	0.000281*	0.000436***	-0.000655	0.00425
	(0.0212)	(0.0073)	(0.00015)	(0.00017)	(0.0061)	(0.0069)
$\Delta Emp_{i,t-5}$	0.00750	-0.000598	0.0000616	0.0000487	-0.00686	0.00606
	(0.0148)	(0.0057)	(0.00013)	(0.00013)	(0.0054)	(0.0062)
Current assets $_{i,t-3}$	0.0203	-0.0341***	-0.000213	-0.0000818	0.000714	0.00648
	(0.0204)	(0.0114)	(0.0001)	(0.00015)	(0.0076)	(0.0095)
Current assets $_{i,t-4}$	-0.00467	-0.0208	-0.000159	0.000192	0.0161*	-0.0196*
	(0.0211)	(0.0130)	(0.0002)	(0.00017)	(0.0088)	(0.0112)
Current assets $_{i,t-5}$	-0.0162	-0.00785	0.00000947	-0.000307**	-0.0163**	0.0111
	(0.0176)	(0.0107)	(0.00017)	(0.00015)	(0.0074)	(0.0091)
$Size_{t-3}$	-2.982***	-1.889***	-0.0367**	0.00526	0.454	-1.339***
	(1.1493)	(0.5731)	(0.0115)	(0.01008)	(0.4288)	(0.5468)
$Size_{t-4}$	1.495	1.772***	0.00517	-0.0142	-0.688	0.261
	(1.1918)	(0.6766)	(0.0143)	(0.0122)	(0.5307)	(0.6555)
$Size_{t-5}$	1.192	-0.284	0.00127	0.0183**	-0.0513	0.802
	(0.9225)	(0.5387)	(0.01142)	(0.0093)	(0.3869)	(0.4947)
$Sales_{t-3}$	-6.285***	1.059*	0.0560***	-0.0211	-0.793	0.868
	(1.8147)	(0.5659)	(0.0161)	(0.0424)	(0.5029)	(0.6795)
$Sales_{t-4}$	4.028***	-1.931***	-0.0541***	0.0145	1.250*	-1.949**
	(1.6493)	(0.7253)	(0.0212)	(0.0365)	(0.6540)	(0.8766)
$Sales_{t-5}$	2.586*	1.238**	0.0305**	0.000763	-0.243	1.577***
	(1.4156)	(0.5706)	(0.0147)	(0.0166)	(0.4605)	(0.6123)
$BankLeverage_{i,t-3}$	-0.0256	0.00665	-0.000871***	-0.000141	-0.101***	0.0436***
	(0.0320)	(0.01789)	(0.0003)	(0.00025)	(0.0143)	(0.0175)
$BankLeverage_{i,t-4}$	0.00801	0.00588	0.000664	0.000566*	0.0669***	-0.0591***
	(0.0378)	(0.0209)	(0.00042)	(0.00032)	(0.0169)	(0.0206)
$BankLeverage_{i,t-5}$	-0.00486	-0.00995	0.0000844	-0.000403	-0.0196	0.0168
	(0.0270)	(0.0156)	(0.00032)	(0.00027)	(0.01255)	(0.0148)
$OtherLeverage_{i,t-3}$	-0.0174	0.0160	-0.000394	-0.000329	-0.0166	-0.0306**
	(0.0266)	(0.0143)	(0.00028)	(0.0002)	(0.0102)	(0.0141)
$OtherLeverage_{i,t-4}$	0.0275	-0.0251	-0.0000427	0.000308	0.0147	-0.0160
	(0.0276)	(0.0170)	(0.00034)	(0.00024)	(0.0120)	(0.0167)
$OtherLeverage_{i,t-5}$	-0.0185	0.0147	0.000264	-0.000173	0.00800	-0.00624
	0(.0207)	(0.0132)	(0.00026)	(0.00019)	(0.0092)	(-0.0125)
Observations	16454	14758	14750	15181	14796	14791
Year fixed effects	YES	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES	YES
Method	OLS	OLS	OLS	OLS	OLS	OLS
R^2	0.0208	0.0136	0.0355	0.1011	0.0167	0.0163
F statistic	3.71	3.16	8	25.11	3.10	3.55
p value	0	0	0	0	0	0

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

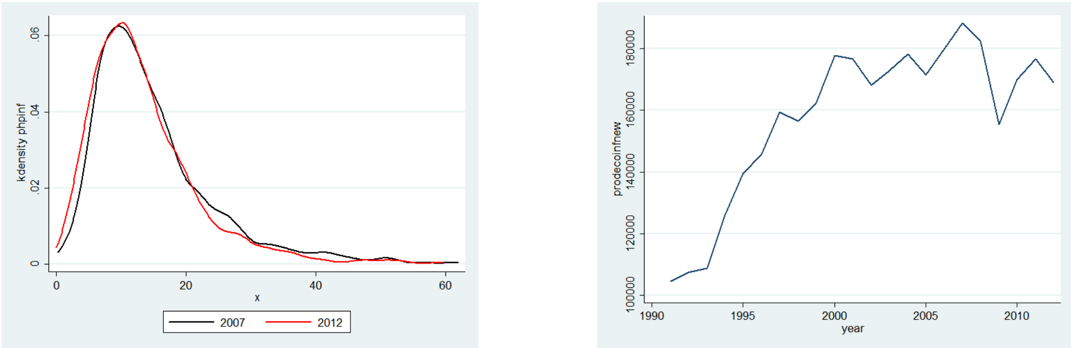
Table 7: Instruments for the difference regression

	(1) $\Delta Emp_{i,t-1}$	(2) Current assets $_{i,t}$	(3) $Size_t$	(4) $Sales_t$	(5) $BankLeverage_t$	(6) $OtherLeverage_t$
$\Delta(\Delta Emp_{i,t-3})$	-0.0212 *	-0.00354	0.000416	0.00115	-0.000601	-0.0150
	(0.0123)	(0.0092)	(0.00091)	(0.0008)	(0.0086)	(0.0096)
$\Delta(\Delta Emp_{i,t-4})$	-0.0276**	0.0138	-0.000938	-0.000248	-0.00953	-0.0123
	(0.0134)	(0.0106)	(0.0011)	(0.0010)	(0.0101)	(0.0117)
$\Delta(\Delta Emp_{i,t-5})$	-0.0241**	0.0154*	-0.00158*	-0.00138*	-0.0119	-0.00675
	(0.0108)	(0.0082)	(0.00088)	(0.0008)	(0.0079)	(0.0089)
Δ Current assets $_{i,t-2}$	-0.0228	0.213***	-0.00296*	-0.00220	-0.0428***	0.00199
	(0.0141)	(0.0166)	(0.0015)	(0.0014)	(0.0127)	(0.0151)
Δ Current assets $_{i,t-3}$	-0.0102	0.209***	-0.00288*	-0.00172	-0.0301**	-0.0113
	(0.0138)	(0.0162)	(0.0016)	(0.0014)	(0.0129)	(0.0154)
Δ Current assets $_{i,t-5}$	-0.0254**	0.183***	-0.00181	-0.000956	-0.0336***	0.00740
	(0.0128)	(0.0151)	(0.0015)	(0.0014)	(0.0124)	(0.0145)
$\Delta Size_{t-3}$	1.697**	-5.774***	0.167**	-0.101	3.277***	-4.427***
	(0.7575)	(0.8439)	(0.0812)	(0.0737)	(0.7159)	(0.8964)
$\Delta Size_{t-4}$	0.410	-5.124***	0.106	-0.201***	2.976***	-4.935***
	(0.7580)	(0.8484)	(0.0833)	(0.0765)	(0.7016)	(0.9123)
$\Delta Size_{t-5}$	1.224*	-3.855***	0.0599	-0.144*	2.269***	-3.362***
	(0.7361)	(0.8157)	(0.0780)	(0.0737)	(0.6630)	(0.8384)
$\Delta Sales_{t-3}$	5.077***	1.614*	0.665***	1.013***	-0.406	5.266***
	(0.9687)	(0.9221)	(0.0917)	(0.0904)	(0.7722)	(0.9597)
$\Delta Sales_{t-4}$	4.523***	-1.612*	0.832***	1.229***	0.840	4.413***
	(0.9337)	(0.9111)	(0.0922)	(0.0857)	(0.7332)	(0.9730)
$\Delta Sales_{t-5}$	2.509***	-0.948	0.812***	1.080***	0.963	5.329***
	(0.7963)	(0.9093)	(0.0896)	(0.0938)	(0.7210)	(0.8941)
$\Delta BankLeverage_{t-3}$	-0.0562***	-0.0230	0.00182	0.00191	0.227***	0.106***
	(0.0214)	(0.0255)	(0.0024)	(0.0021)	(0.0218)	(0.0237)
$\Delta BankLeverage_{t-4}$	-0.0476**	0.0136	-0.00188	0.0000148	0.249***	0.0689***
	(0.0218)	(0.0252)	(0.0024)	(0.0022)	(0.02064)	(0.0234)
$\Delta BankLeverage_{t-5}$	-0.0543***	0.0312	-0.00472**	-0.00323	0.180***	0.0405*
	(0.0197)	(0.0240)	(0.0023)	(0.0021)	(0.0198)	(0.0219)
$\Delta OtherLeverage_{t-3}$	-0.0391***	-0.0123	0.00818***	0.00905***	0.0387***	0.275***
	(0.0161)	(0.0212)	(0.0021)	(0.0019)	(0.0164)	(0.0210)
$\Delta OtherLeverage_{t-4}$	-0.0166	-0.0172	0.00582***	0.00717***	0.0277*	0.268***
	(0.0172)	(0.0215)	(0.0021)	(0.0019)	(0.0155)	(0.0203)
$\Delta OtherLeverage_{t-5}$	-0.0266*	0.0126	0.00255	0.00347*	0.0140	0.202***
	(0.0158)	(0.0202)	(0.0020)	(0.0018)	(0.0144)	(0.0183)
Observations	13958	12643	12640	12922	12662	12658
Year fixed effects	YES	YES	YES	YES	YES	YES
Industry fixed effects	YES	YES	YES	YES	YES	YES
Method	OLS	OLS	OLS	OLS	OLS	OLS
R^2	0.0099	0.0365	0.0253	0.0416	0.0409	0.040
F statistic	6.17	23.64	18.56	27.59	24.96	25.9
p value	0	0	0	0	0	0

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 8: Instruments for the level regression

more centered on the right. Last, in figure 27 I present the average age of small manufacturing firms that survived the crisis (green line), and small firms that died during the crisis (red line). At 2007, the sample had 800 small firms, of which 150 will die during 2008-2012. According to Schumpeter, the old firms should disappear first during the crisis. However, the average age of the firms that are destroyed increases during the crisis, i.e. the younger ones disappeared first.



(a) Distribution of productivity (2007-2012) (b) Total productivity

Figure 26: Distribution of productivity and total productivity

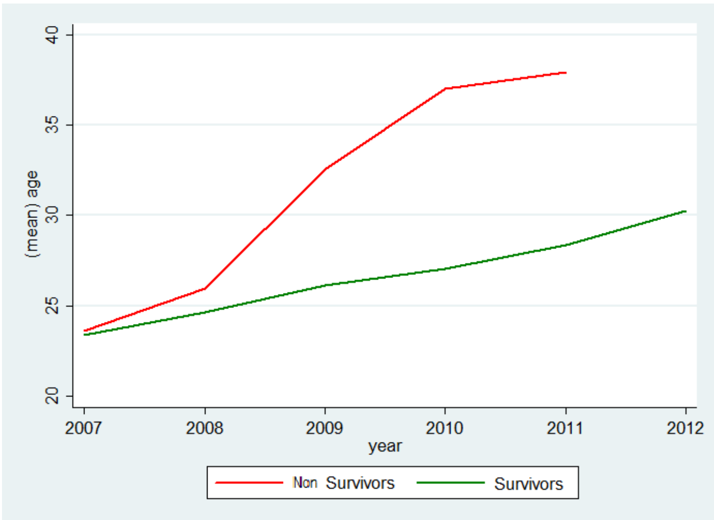


Figure 27: Average age: Survivors vs non survivors

1.5.4 Distribution of firms

In this section I show that the distribution of firms is changing during the crisis. This way I justify the use of two separate analysis in section 1.2, the cross section analysis and the life cycle analysis. Tables

9 and 10 are obtained from INE (Instituto Nacional de Estadística). In table 9 I show the percentage of small, big and medium firms over the total number of firms in 2002 and 2007, and in table 10 from 2008 to 2014. Notice that from 2002 to 2007 this distribution did not change. Small firms represented around 14.9%, medium firms represented around 2.3% of firms and big firms represented 0.58% for both 2002 and 2007. However, the distribution changed during the recent crisis as can be seen in table 10. Small and medium firms lost more weight in the economy that big firms.

Size of firm	2002	2007
From 10 to 49	14.85	14.92
From 50 to 199	2.32	2.282
From 200 onwards	0.575	0.58

Table 9: Distribution of firms. Spain. 2002-2007

Size of firm	2008	2014
From 10 to 49	14.85	14.92
From 50 to 199	2.32	2.282
From 200 onwards	0.575	0.58

Table 10: Distribution of firms. Spain. 2008-2012

1.5.5 Cohorts comparison with constant number of firms

As commented in section 1.2.2, in the life cycle analysis, when comparing firms of different cohorts it should be taken into account that some firms disappeared from the sample (maybe because they closed or just because they stop answering the survey of ESEE). It could be argued that this fluctuation in the number of firms could change the analysis and the conclusions. Consequently, I present similar figures as the ones in section 1.2.2, but taking into account only the firms that survived the whole period. I do only the 1991-1994 vs 1995-1998 vs 1999-2002 analysis, because I do not have enough constant observations for the 1991 vs 1994 vs 1998 analysis. Results are shown from figure 28 to figure 30. The number of firms is 40 in the case of 1991-1994, 40 for 1995-1998, and 20 for 1999-2002. Most of the series follow the same pattern as in section 1.2.2, in which I was using all firms, not just the ones that survive the entire sample. Total employment, figure 28, behaves as in section 1.2.2: Manufacturing firms in Spain started with 22 employees proximately, they grew on average, and during the crisis they got smaller. The older the firms were, the bigger (in terms of workers) they arrived to the crisis, and the less they decreased their size during crisis. Also total leverage, figure 29, behaves as in section 1.2.2: Firms were born with more than 70% of total leverage, then a deleverage process took place as firms got older, and the older the firm, the less it deleveraged during crisis. Bank leverage is shown in figure 30. As in section 1.2.2, figure 30 shows that firms were born with around 21% and 23% of bank leverage, and as they got older, they tried to reduce their bank dependency. Additionally, the younger the firm during crisis, the more it reduced bank leverage.

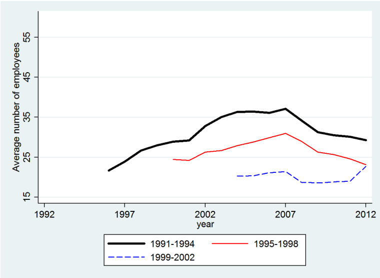


Figure 28: Employment. 91-94 vs 95-98 vs 99-02. Constant firms

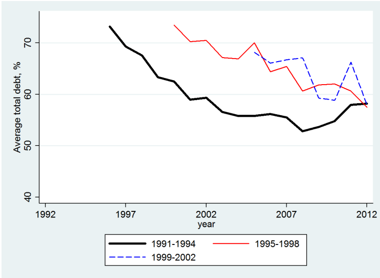


Figure 29: Total leverage. 91-94 vs 95-98 vs 99-02. Constant firms

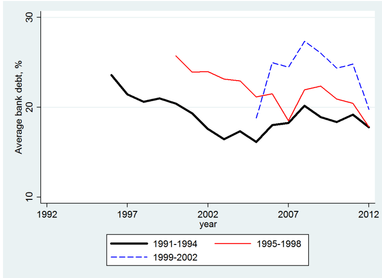


Figure 30: Bank leverage. 91-94 vs 95-98 vs 99-02. Constant firms

1.5.6 Spain and the credit crunch

A big part of the literature regarding financial restrictions is focused in USA or developing countries. However, Spain is an ideal scenario in order to study financially vulnerability. First of all, Spanish economy experienced a big credit crunch: bank lending has decreased considerably since 2008 to 2014, as it is documented in the Boletín oficial estadístico del Banco de España. From this bulletin I create figure 31 in which I represent growth of credit from financial institutions in Spain from 1993 to 2014. As it can be seen in that figure, during the period 2002-2007 there was an impressive expansion of credit, this expansion froze in 2008 and since then credit decreased.

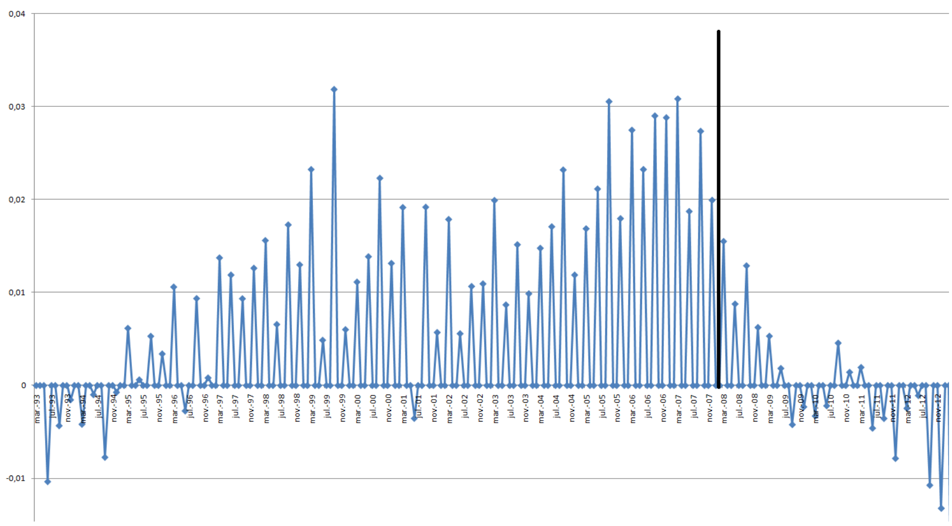


Figure 31: Growth of credit from financial institutions

	2005	2006	2007	2008	2009
Germany	34.5	34.4	38.2	37.9	37.4
France	35.3	42.1	47.9	43.4	43.4
Italy	45.3	49	53.3	56.1	56.6
Spain	63.8	77.7	86.2	89.1	88.8

Table 11: Loans from credit institutions to non financial firms divided by the GDP

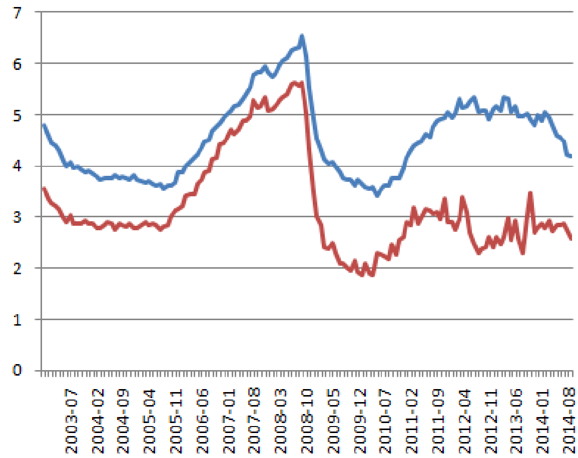
Secondly, Spanish firms are more bank-dependent borrowers that most of its European counterparts. This can be appreciated in table 11, constructed from EU banking report (ECB 2010). It shows the ratio of loans from credit institutions to non financial firms divided by the GDP of the country, from 2005 to 2009. This gives an idea of the weight and importance of credit in each economy. While in Germany, France or Italy, loans from credit institutions to non-financial corporations represented less than 50% of the GDP (for Italy is roughly 50%), in Spain loans from credit institutions to firms represented almost 90% of the GDP by 2008.

Spanish firms are more bank dependent and bank lending has been reduced a lot in Spain. In this country there exist the two forces through which finance can affect the real economy (lack of credit and financial restrictions) so it seems an ideal scenario to determine which firms can be financially vulnerable at the onset of the crisis. Despite the fact that lending from banks have been reduced during the crisis, it can be argued that this is caused by a demand shock rather than a supply shock. Is there evidence of the existence of a credit crunch? I will present three facts that provide support to the idea of the supply shock (although there might be present demand factors too): The evolution of the interest rates, the amount of rejected credits, and the evolution of the credit lending standards.

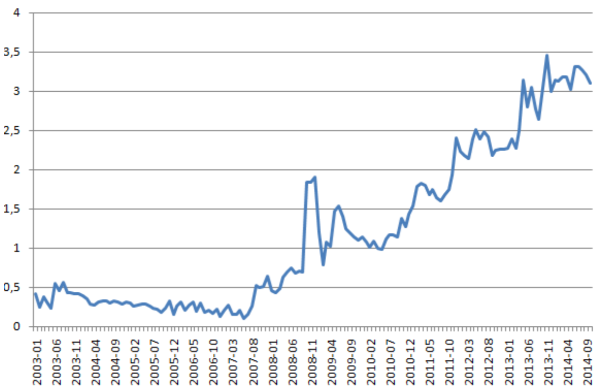
Evolution of interest rates

Figure 43a represents the evolution of interest rates of loans from credit institutions to non financial firms in Spain from 2003 to 2014. Blue line represents average interest rates of credits below one million euros. Red line represents average interest rates of credits over one million euros. The former can be considered as a proxy of how expensive is borrowing for small and medium firms from banks, and the latter can be considered a proxy of how expensive it is for bigger firms. Figure 43a shows that for the whole sample, interest rates are always higher for smaller firms. Also, this gap became bigger during the crisis. From 2005 until October 2008, interest rates of loans from credit institutions increased a lot for both credits up to one million and credits over one million. In October 2008, BCE decreased reference interest rates from 5.25 to 4.25, and by May 2009 to 1.75. These drops were partially transmitted to the rates at which banks were lending to non financial firms. However, a wide gap was created between interest rates of credits up to one million and interest rates of credits over one million. That gap has been not closed. In fact, it got bigger during the crisis, as further decreases in the ECB lending rates were not transmitted to private rates. The failure in this transmission seems to affect more severely to small and medium firms.

In order to understand better the failure in the transmission, in figure 43b I show the differential between ECB reference lending rates and average interest rate from credits institutions to non financial firms in Spain. Before the crisis, the differential was very small, below 0.5%. The intense decrease of ECB interest rates from October 2008 to May 2009 was transmitted partially to private rates, so the differential grew until 1%. But from May 2010 onwards, further decreases of ECB interest rates were not transmitted at all to private rates, so the gap between ECB rates and privates rates increased a lot during the rest of the crisis (up to 3.5%). This differential seems to affect more to small firms, as the gap between credits below one million euros and credits over one million also increased. This evolution of prices is more consistent with the claim that in Spain there is a supply shock.



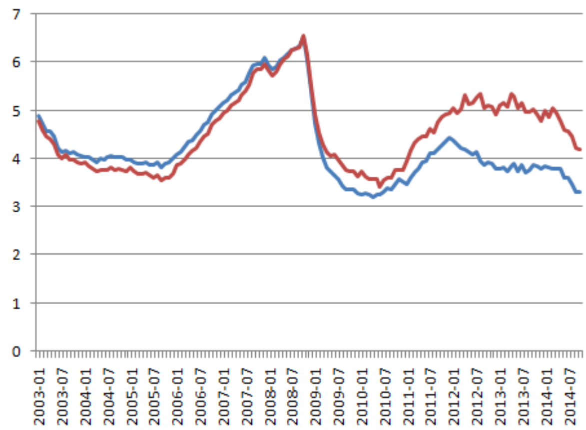
(a) Spain: Rates up to and over 1 million



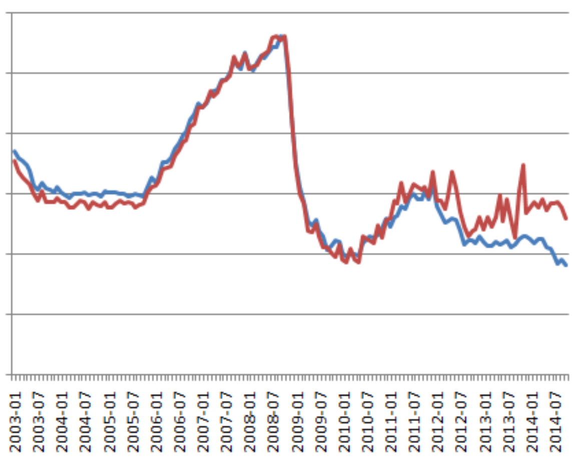
(b) Private rates over ECB rates, Spain

Figure 32: Private interest rates and ECB rates

In addition, in Spain the situation for smaller firms is worse than in the Eurozone. In figure 44a I represent interest rates below one million for Spain (red) and for Eurozone (blue). In 44b I represent interest rates above one million for Spain (red) and for Eurozone (blue). In both cases, before the crisis Spanish firms were borrowing at the same rate as the rest of their counterparts in Europe. However, after the crisis, interest rates for Spanish firms become higher than in the rest of the Eurozone. This gap is bigger for smaller Spanish firms, as it can be seen in figure 44a.



(a) Spain vs Europe: Rates up 1 million



(b) Spain vs Europe: Rates over 1 million

Figure 33: Private interest rates. Spain and Europe

Amount of rejected credits

Now I turn to analyze the amount of rejected credit as a source of evidence of a credit supply shock in Spain. In tables 12 and 13 I show the percentage of rejected credits in Spain, Italy, France and Germany, as documented by Amadeus (2013). Table 12 includes partially or totally rejected loans for Spanish firms of different sizes. It can be seen that for all sizes (especially for medium ones), the amount of rejected loans is around half of total loans demanded. Spanish firms are in a worse situation than its counterparts in Eurozone, table 13. In France or Germany, the amounts of rejected loans barely reach 20% during the crisis, whereas for Spain in 2009 was 51% and in 2012 was 45%. Only Italy can be compared to the Spanish cases, but the Italian ratio of rejected loans is always lower than in Spain.

	2009	2010	2011	2012
Small	50.9	44	35	44
Medium	51.9	41	42	51
Big	59.9	28	29	44

Table 12: Amount of rejected credit. Spain

	2009	2010	2011	2012
Total Germany	18.9	23	10	8
Total France	15.3	18	18	19
Total Italy	26.8	32	36	49
Total Spain	56	37	36	45

Table 13: Amount of rejected credit. Cross country comparison

Evolution of lending standards

The evolution of lending standards can also help to determine if there is actually a supply shock. Tables 14 and 15 are also obtained from Amadeus (2013), and indicates the percentage of firms that found that lending standards were tougher that year with respect to the year before. In table 14 I show the results for different sizes of Spanish firms. It can be seen that a majority of firms found every year that lending standards were getting tougher (especially for small and medium firms after 2009). Differences with respect other European countries are considerable, table 15. The percentage of Spanish firms that find that lending standards were increasing during 2009-2012 is more than double that the percentage in Germany. In Italy and France the situation is worse than in Germany, but still better than in Spain. Finally, in tables 16 and 17 I report the percentage of firms that report that interest rates on bank loans were increasing each year. In table 16 I represent Spanish firms of different size. Except in 2009, a majority of Spanish firms of any size found that interest rates were increasing. The percentage is over 80% in 2011. Again, Spanish firms' situation is worse than firms from Italy, Germany or France. Table 17 shows that, while in France and Germany firms found during 2009, 2010 and 2012 that interest rates were going down, in Italy and Spain it was the other way around. Especially in Spain, where since 2009 more than 50% of firms find that interest rates are increasing year by year.

The evolution of interest rates, the increase in lending standards and the high amount of rejected credits seems to indicate that Spanish firms are affected by a supply shock of credit. The situation is more dramatic taking into account that Spanish firms rely much more on bank credit. Firms in Spain suffer more the credit crunch consequences than their counterparts in Germany, Italy of France. Consequently, Spain seems the ideal place to study the consequences of financial vulnerability.

	2009	2010	2011	2012
Small	46	58	57	57
Medium	46	46	43	59
Big	58	45	39	44

Table 14: Lending standards with respect to the year before. Spain

	2009	2010	2011	2012
Total Germany	23	26	12	18
Total France	33	26	41	35
Total Italy	27	26	31	38
Total Spain	46	51	43	53

Table 15: Lending standards with respect to the year before. Cross country comparison

	2009	2010	2011	2012
Small	37	57	87	73
Medium	22	56	84	77
Big	43	57	85	68

Table 16: Bank interest rates increases. Spain

	2009	2010	2011	2012
Total Germany	-6	-8	24	-30
Total France	-6	-22	49	-16
Total Italy	2	21	75	69
Total	37	53	81	70

Table 17: Bank interest rates increases. Cross country comparison

2 Access to credit: Firm size matters

2.1 Introduction

A key question for macroeconomists has been how firms react to a financial crisis. For the last 40 years different theories and mechanisms have tried to explain the importance of finance for the business cycles, the bank lending channel by Bernanke and Blinder (1989) probably being the most influential. The recent crisis has renewed the interest on this topic. Using the panel data on Spanish manufacturing firms provided by Encuesta Sobre Estrategias Empresariales (ESEE from now on, survey of business strategies) I undercover two empirical facts about this question. First, big firms[13] kept total debt constant while smaller firms decreased it from 2008 to 2012. During that period small firms decreased total leverage by 12% and medium firms by 9%, whereas big firms managed to keep total leverage constant. The second fact is that bigger firms kept debt constant during crisis because they could better interchange bank debt and non bank debt (also called other debt). During 2008 and 2009 short other debt[14] decreased considerably for small and medium size ones. This decrease was less severe for bigger firms. In addition, during those years only big firms were able to increase its bank level position. This might indicate that bigger firms were able to keep total leverage constant by better interchanging one kind of debt by another.

The goal of this paper is to build a quantitative macroeconomic framework that can account for these two facts. This is a relevant question since the ability to interchange one kind of debt by another can influence firms' growth and dividends smoothing, as my results show. My model is populated with manufacturing firms and suppliers. The main agents of the model are the manufacturing firms. They produce final goods using non durable inputs and durable inputs. Non durable inputs are obtained from suppliers and durable inputs are obtained through investment. All manufacturing firms have access to a collateralized debt. It consists of one period bond obtained from a financial intermediary, and it is subject to a collateral constraint that depends on firms' stock of durable inputs. It represents bank debt in the data. Manufacturing firms can be attached or unattached to the suppliers. If they are attached they have access to a second type of debt, uncollateralized debt, that will represent trade debt or short other debt in the data. Timing for manufacturing firms is as follows: At the beginning of

[13] European standards about firm size consider small firms the ones from 10 to 50 employees, medium firms from 51 to 250 employees, and big firms from 251 above.

[14] Short other debt: Suppliers, trade credit, delayed payments to workers.

a given period, manufacturing firms start attached to a particular supplier from which they buy non durable inputs. Suppliers require that at least a fraction of the non durable input should be paid in advance. Manufacturing firms do not have retained earnings in this model so they need a way to finance this payment. Attached manufacturers delay this payment through uncollateralized debt, one period bond that suppliers themselves grant and price according to a Nash bargaining negotiation. If a Nash bargaining agreement is not reached, threat point results on detachment from the current supplier, and getting attached each period to a new supplier. New suppliers will still demand that a fraction of the non durable good bill should be paid in advance, but they will not grant uncollateralized debt to the manufacturing firm. Therefore unattached manufacturing firms are obliged to use collateralized debt for this payment in advance. This implication is particularly painful for firms that do not have sufficient collateral to raise additional bank debt.
Suppliers are homogenous and randomly attached with manufacturing firms. They remain attached as long as a Nash bargaining agreement is reached while negotiating the interest rate of the uncollateralized debt. For the supplier, the bargaining agreement results on remaining attached to the manufacturing firm and the charge of the resulting interest rate. The threat point for not reaching an agreement is that they get unattached from the current manufacturing firm, and then exit the market.

The solution is obtained through Occbin, a toolkit for Dynare by Guerrieri and Iacoviello (2015) that allows for solving occasionally binding constraints in a piecewise fashion. The two occasionally binding constraints are the one referring to the collateral debt, and the constraint on the fraction of delayed payments on input demand, i.e. the choice of uncollateralized debt. I seek to capture the simultaneous decrease in both kinds of debt by small and medium firms, the dynamics of bank debt and short other debt for big firms, and the rise in interest rates of both debt instruments. I analyze the response of the model to a technology shock and a financial shock. I show the responses of the benchmark model and of a counterfactual model in which trade debt conditions are constant, favorable and homogeneous across firms. In the benchmark exercise, manufacturing firms are badly hit after the realization of both shocks. Suppliers are able to extract surplus from them through the Nash bargaining game, raising the trade debt interest rate for all firms. Smaller manufacturing firms are binding on the collateral constrain in steady state, so they cannot use bank debt to smooth the effects of the shocks. These smaller firms are eager for more funds; therefore suppliers are able to impose an even higher increase on uncollateralized debt interest rate. As a result there is a enormous extra cost for non durable goods demand, specially for smaller firms. These firms experience a stronger deleverage process from both kinds of debt, and huge decrease of dividends and non durable demand. Big firms have the possibility of using additional bank debt to finance the payment in advance. This makes the threat point less painful for them, preventing suppliers from extracting much surplus from the Nash bargaining. Uncollateralized debt interest rate does not increase so much for big firms. One of the conclusions from this exercise is that uncollateralized debt (representing trade debt) has been on average an extra cost, instead of being a source of liquidity for firms that need it. Suppliers are not acting as insurance providers as it is argued in the literature, for instance in Cunyat (2007). Trade debt could have been an important source of liquidity, particularly for small firms. However, this result does not seem consistent with the data or my benchmark exercise. Small and medium firms are precisely the ones that experience a bigger drop in trade debt during crisis. I perform a counterfactual experiment in which uncollateralized debt rates are low and constant during crisis. In that scenario smaller firms find optimal to increase trade debt in order to smooth dividends and mitigate the real effects of both shocks. The model predicts that, when bank-constrained firms have access to favorable trade debt conditions, they are able to use trade debt in order to soften the real effects of the crisis.

This paper is related to three types of literature. Firstly, to the literature that studies financial frictions, firm dynamics and collateral constraints. The fact that bigger firms are less affected by financial frictions has been a key point of the aforementioned literature. Some good examples are Buera and Shin (2013), Khan and Thomas (2013). They also use a collateral constraints that can be occasionally binding, and show that better access to credit by big firms allows these firms to mitigate the real effects of a financial crisis. However, they concentrate only on bank debt and this could be misleading. First, it could underestimate the effects of financial frictions on smaller firms. Financial frictions make smaller firms more constrained on their bank debt, but also on their trade debt. Secondly, it could lead to wrong policy implications. Noticing only bank debt would suggest policy makers to focus only on bank finance, while bank finance accounts for less than 40% of total finance in the data. Therefore ignoring debt heterogeneity is misguiding. There have been a few recent research attempts regarding the importance of different kind of debts. In that sense, two relevant examples are Crouzet (2014) and De Fiore and Uhlig (2011). In their models, firms have access to either bonds or bank debt. But data shows that bond finance is only a relevant source of finance for very big firms. For small and medium manufacturing firms, bond issuance represents less than 8% of the total debt while bank debt and trade debt represents more than 30% respectively. The dynamics of bank debt and short other debt are more relevant to explain the behavior of firms of different sizes during a recession. My paper is the first one that documents the importance of firms' ability to interchange bank debt and trade debt.

Secondly, my paper is connected to the literature on trade debt. Literature about trade debt is mostly empirical but there have been some attempts to create a theory of trade debt. Cunyat (2007) proposes a model in which suppliers have a lending comparative advantage with respect to banks, and could act as liquidity providers. My model does not necessarily contradict this point of view, but predicts that during the last crisis the role of suppliers as liquidity providers was not fulfilled. There are two recent papers that do acknowledge the aggregate importance of trade debt in the economy. Shao (2016) uses a DSGE models with two types of debt, and tests what are the implications of trade credit drop in the economy. However, in her model trade debt is priced in a competitive way and she cannot account for the worsening conditions of trade debt conditions for smaller firms. Altinoglu (2016) proposes a network economy in which all firms borrow trade credit from their supplier and lend trade credit to their clients. He estimates how this network based on trade debt affects the economy. But he cannot account for the importance of the interchangeability of bank debt and trade debt, or the worsening conditions of trade debt for smaller firms.

Last, my paper is related to the literature on firms' vulnerability and capital structure of firms. Traditional wisdom about firms' vulnerability was set by Schumpeter. According to him, the old and non productive firms should be the most vulnerable during a crisis (Schumpeter, 1942), through the process of *creative destruction*. Since smaller firms tend to be younger, my conclusions contradict this traditional point of view. In more recent literature, there is a lack of descriptive work with firm level data about debt heterogeneity. Cooley and Quadrini (2001), and Arellano et al. (2012) also document that small firms tend to have more leverage in financially developed countries, but they do not differentiate between different kinds of leverage, and they cannot account for the recent financial crisis. González (2012) find that higher leverage and maturity increases firms vulnerability during the recent crisis, but they do not differentiate between kinds of leverage, and they focus in developing economies. Consequently, I contribute to this literature by documenting financial patterns in a developed country with micro level data and by differentiating between bank and short other debt.

The remainder of the paper is organized as follows: Section 2.2.1 presents the two empirical facts, while section 2.2.2 presents the mapping between short other credit and trade credit. Section 2.3 contains the theoretical framework, section 2.4 the calibration, section 2.5 the results and section 2.6 contains the conclusion. The appendix, section 2.7, includes definitions of the variables and other relevant information.

2.2 Empirical analysis

2.2.1 Empirical facts

In this section I show in detail the two empirical facts that motivate this paper. Firstly, from 2008 to 2012 big firms kept debt constant while smaller firms decreased debt. Secondly, big firms managed to keep debt constant by interchanging better bank debt and other debt. All the data comes from ESEE. This survey is conducted by te Spanish government and the SEPI foundation. They send a questionnaire to Spanish manufacturing firms, getting reliable answers from around 2200 firms each year since 1991. They keep the number of companies interviewed each year constant. Firms are required to answer the questionnaire year after year, and if any firm disappear or stop answering to the questionnaire, then ESEE substitutes it with a firm of similar characteristics. The survey provides data about firms of all sizes, but I disregarded firms with less than 10 employees because there were not sufficient observations about them. The sample is representative for the rest of sizes in Spain. It contains 3% of total small manufacturing firms (around 1000), 5% of medium manufacturing firms (around 600), and almost 20% of big manufacturing firms (250 approximately).

1^{st} **empirical fact:** *Which firms decreased debt? From 2008 to 2012, big firms kept debt constant, while smaller firms decreased debt.*

I present in figure 34 and in table 18 the evolution of total leverage for different sizes of firms in 2007, 2012 and the percentage of deleverage. Total leverage is the percentage of debt over assets. One year before the crisis started, in 2007, small firms had more total leverage (59.2%) than medium and big firms (57%). From 2008 onwards, small firms decreased total leverage by 12%. Medium firms also decreased their total leverage considerably, by 9.2%. On the other hand, big firms experienced a decrease in total leverage of only 1%. As a result, correlation between size (measured as assets) and total leverage (measured as total amount of debt in euros) has been reverted during the crisis. From 2000 to 2007 the correlation was -0.07. This is consistent with the fact described in Arellano et al. (2012) who affirms that in financially developed countries smaller firms have more total leverage. However, from 2008 to 2012 this correlation got reversed to 0.03.

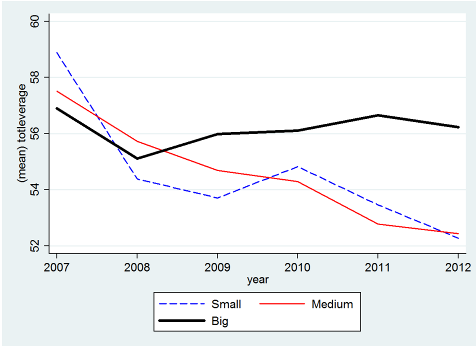


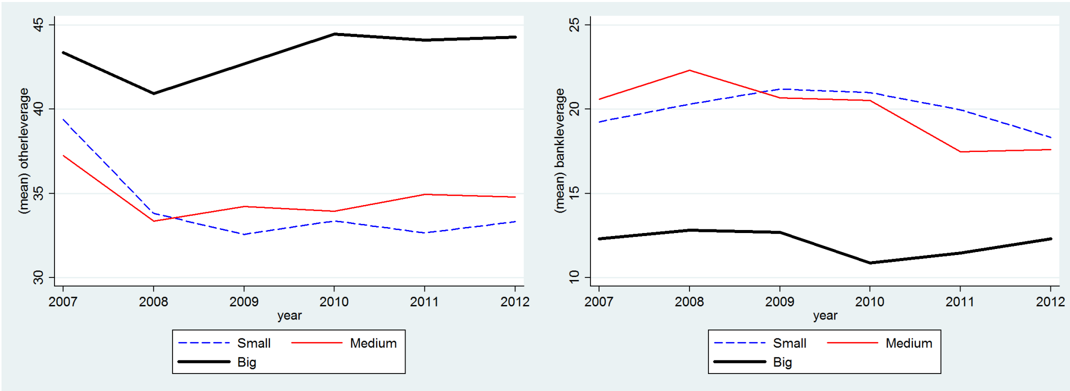
Figure 34: Total leverage 2008-2012

μ	2007	2012	%Deleverage
Small firms	59.2	52.15	−11.9%
Medium firms	57.50	52.23	−9.2%
Big firms	56.89	56.22	−1.18%

Table 18: Total leverage, 2008-2012

2^{nd} **empirical fact:** *Why only big firms kept debt constant? Big firms interchange better bank debt and other debt.*

In order to answer why only big firms kept debt constant, most of the literature has focused either on one kind of debt or only on bank debt. But I show that it is necessary to understand the evolution of different kinds of debts when addressing this issue. Total leverage is the sum of bank leverage and other leverage. Figure 35 and table 19 show the behavior of both kinds of leverage for firms of different sizes in 2007 and 2012, and the amount deleveraged during crisis. I want to highlight three aspects from figure 35 and table 19. Firstly, all firms use more other leverage than bank leverage. Secondly, big firms use more other leverage and less bank debt than medium or small firms. And third, the dynamics of both kinds of debt during the crisis were very different for each firms' size. From 2008 to 2012, other leverage decreased 15% for small firms and 7% for medium firms, while it stayed more or less constant for big firms. However, it is interesting that all kind of firms experimented a severe decrease of other leverage during 2008, although this decrease was less intense for big firms. Regarding bank debt, big firms, who rely less on bank debt than other firms, did not experience a change in their bank position during crisis. Bank leverage decreased 6% for small firms and 14% for medium firms. This decrease was smooth over the years; it did not experience a sudden decrease on 2008 like happened with other leverage. Instead, the decrease of bank leverage started after 2008.



(a) Other leverage (b) Bank leverage

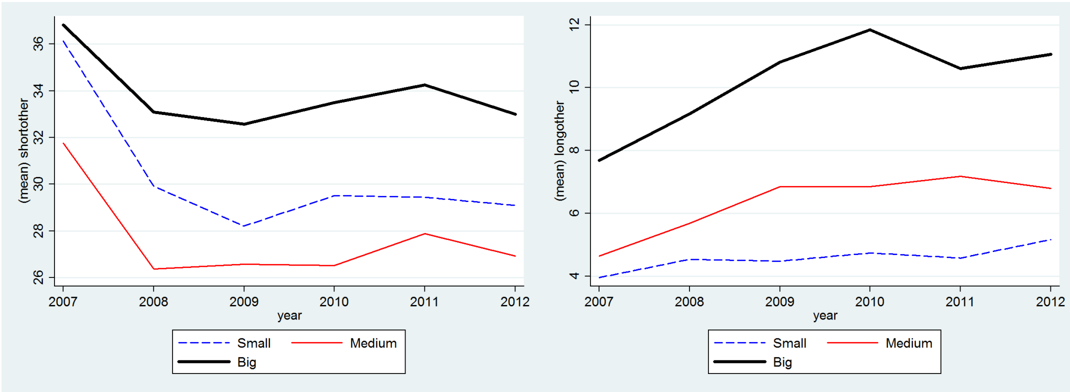
Figure 35: Bank and other leverage, 2008-2012

μ	2007 other	2012 other	%Delev	2007 bank	2012 bank	%Delev
Small	40.05	33.94	−15.25%	19.44	18.32	−5.76%
Medium	36.32	33.59	−7.51%	20.38	17.54	−13.92%
Big	44.46	44.06	−0.89%	12.26	12.3	+0.32%

Table 19: Bank leverage and other leverage, 2008-2012

What drove these decreases in other leverage during crisis? I go further in order to understand why other leverage behaves in such a way. Other leverage is equal to short other leverage plus long other leverage. Short other leverage includes non financial obligations due to less than one year: Trade credit, delayed payments to workers, advance from costumers and public administrations. Long other debt represents firm bonds due to more than one year. Evolution of short and long other leverage is shown in figure 36 and table 20. I focus on two features from this figure and this table. First, short other leverage has a bigger weight than long other leverage for all kind of sizes. Short other leverage is around 30% of total leverage while long other leverage is below 10%. And secondly, the huge decrease on total leverage in 2008 was produced through a decrease on short other leverage. This decrease was common for all sizes of firms, although it was less severe for bigger firms. During the whole crisis, short other leverage decreased by 20% for small firms, by 16% for medium firms and by 10% for big firms. Long other debt in contrast increased significantly for all firms. This means that bond market increased its importance during crisis. However, the weight of long other debt over the total debt is still very low, so those increases in long other debt were not very significant on total leverage. In any case, in this paper I focus rather on the interaction of short other leverage and bank credit, and I leave aside the analysis of long debt.

Now I show the growth rates of short other leverage and bank leverage for firms of different sizes in



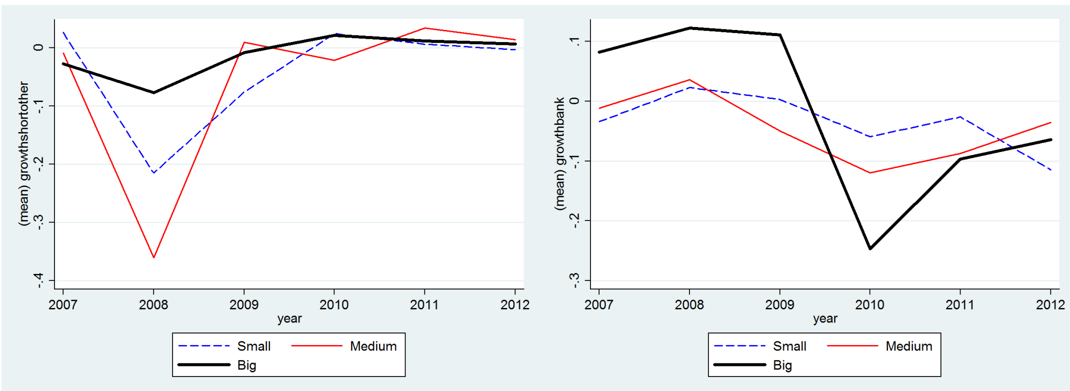
(a) Short other leverage (b) Long other leverage

Figure 36: Short and long other leverage, 2008-2012

μ	2007 Short	2012 Short	%Delev	2007 Long	2012 Long	%Delev
Small	35.91	28.57	−20.43%	4.14	5.38	+29.95%
Medium	31.70	26.62	−16.02%	4.62	6.96	+50.64%
Big	36.74	32.99	−10.20%	7.72	11.06	+43.23%

Table 20: Short and long other leverage, 2008-2012

figure 37. This way it can be appreciated how big firms interchange better one kind of debt by another. In figure 37 it can be seen that big firms were able to raise bank credit during 2008 and 2009, the years in which short other leverage was decreasing considerably. The decrease of short other leverage was very intense for all firms in 2008: more than 20% for small firms, more than 30% for medium firms and around 10% for big firms. However, during 2008 and 2009, big firms were able to raise bank debt by more than 10%, while small and medium firms were unable to raise bank credit.



(a) Growth short other leverage (b) Growth bank leverage

Figure 37: Growth of short other leverage and growth of bank leverage, 2008-2012

I summarize the findings up to now. First of all, most of the total deleverage experienced by firms in early years of the crisis has been produced through an enormous decrease in short other leverage during 2008 and 2009. During those two years, the decrease of short other leverage was very intense, up to 30% for medium size firms. This decrease was less severe for bigger firms, around 10%. Secondly, during the last years of the crisis, deleverage of small and medium firms have been produced through bank credit. And last, when short other leverage dropped massively in 2008, big firms seemed to interchange better short other credit by bank credit. Overall, big firms seem to have better access to credit since they avoid total deleveraging thanks to these dynamics.

In section 2.3 I develop a theoretical framework that could account for this better accessibility to credit during crisis by big firms. Firms have access to bank debt, represented as a collateralized debt, and to trade debt, represented as an uncollateralized debt. Bank debt in the model will have a direct mapping from bank debt in the data. In section 2.2.2 I explain how do I map short other leverage to trade credit.

2.2.2 Short other credit and trade credit

As said before, short other credit in the panel data of ESEE includes:

- Suppliers/trade credit
- Delayed payments to workers
- Advance from customer
- Public administrations

Unfortunately, I cannot disentangle in my data which part of short other credit belongs to each account. I would like to know which part of short other credit belongs to trade credit. I use data from “Boletín Económico Banco de España” from February 2012 in order to do that. In this document, Bank of Spain determines which was the percentage of trade credit with suppliers over total credit. Results are shown in table 21. Trade credit is about more than half of short other credit for small and medium firms. Also, table 21 shows that during 2008 and 2009 there was a huge decrease on trade credit, specially for small and medium firms. This is consistent with the decrease of short other credit that I showed in figure 37. Consequently, table 21 suggests that a big part of the decrease of short other leverage was driven by a decrease in trade credit.

I have shown that small and medium firms had to decrease short other credit (and consequently trade credit) more than big firms. But before finishing this section I will like to point another source of disadvantage for smaller firms. Trade credit is negotiated within 60 to 90 days. During the 2008 crisis, payment periods experienced important changes. In table 22, also from "Boletín Económico Banco de España" February 2012, I show average payment days from clients to firms, and from firms to their suppliers. Data is shown for manufacturing firms of all sizes. From this table it can be seen that small firms suffered more those changes in payment days. Clients delayed payments to them, and they were not able to translate this increase in payment days to their suppliers. Small firms were net lenders during crisis. But for big firms it was exactly the opposite, they were able to translate delay payments from their clients to their suppliers. This could represent the bigger bargaining power of big firms: They constitute an important costumer for their suppliers, and suppliers are more willing to provide liquidity to them.

To recap, bigger firms seem to be in a better position with respect trade credit. As I show in figure 37, short other leverage decreased less for bigger firms. Table 21 confirms that a big fraction of this short other credit corresponds to trade credit, and that big firms reduced less their trade credit in comparison with smaller firms. Furthermore, not only the decrease of the leverage, but also the payment days were more favorable to big firms. During the 2008 crisis, smaller firms become net lenders while bigger firms were able to improve their position with respect with suppliers. In the model that I present in next section, I attempt to capture the fact that trade credit conditions during the 2008 crisis were better for big firms.

Trade credit	2007	2008	2009
Small	19.2	15.4	13.9
Medium	17.9	14.5	13.6
Big	13.3	11.5	12.8

Table 21: Trade credit, 2008-2012

Payment days	07 clients	08 clients	09 clients	07 suppliers	08 suppliers	09 suppliers
Small	79.2	85.8	94.9	101.3	91.4	105.4
Medium	88.6	81.3	87.3	85.8	72.4	80.7
Big	57.9	48.2	61.9	61.3	57.6	85.2

Table 22: Payment days, 2008-2012

2.3 Theoretical model

My theoretical model consists on a partial equilibrium economy populated with manufacturing firms, suppliers and an external financial intermediary or bank.

2.3.1 Manufacturing firms

Manufacturing firms use non durable input m_t and durable input k_t to produce an homogenous final good y_t. This final good is produced through a strictly concave production function $F(m_t, k_t)$ with decreasing returns to scale.

$$y_t = F(m_t, k_t) = z_t m_t^{\alpha_m} k_t^{\alpha_k} \text{ with } \alpha_m + \alpha_k < 1$$

Durable input k_t depreciates at rate δ. Firms are subject to an aggregate productivity shock z_t, that evolves according to $z_t = \rho z_{t-1} + \sigma \epsilon_t$ where ρ and σ are parameters and ϵ represents the exogenous iid shock, distributed as a normal with zero mean and variance σ.

Manufacturing firms can have access to two kinds of debt: Collateralized debt, b_t, and uncollateralized debt, a_t. All firms have access to collateralized debt, which represents bank debt. It is provided by a representative financial intermediary. Through the paper I also refer to this intermediary as the representative bank, or just the bank. I assume that this bank lends to the manufacturing firm one period noncontingent bonds b_t at rate r_t^b. The amount of debt b_{t+1} that a manufacturing firm can raise at t is subject to a collateral constraint (1), in which durable goods serve as collateral. This collateral constraint can be thought as a feature derived by a limited enforcement problem like in Kiyotaki, Moore (1997). The representative bank will be only able to collect a fraction $(1-\theta_t)$ of durables goods in case of default:

$$b_{t+1} \leq (1-\theta_t) k_{t+1} \quad (1)$$

The exogenous variable θ_t stresses the severity of the financial friction. A bigger θ_t means that less collateral credit can be raised, given a level of durable goods. In calibration section I specify how θ_t evolves. Bank debt can be useful to smooth dividends and invest. On the other hand, attached manufacturing firms can have access to uncollateralized debt a_t. It represents trade debt and appears as a result of the interaction of the manufacturing firm and the supplier. I specify below how this debt is determined.

At the beginning of period t, manufacturing firms will be defined by its holdings of $k_t \in K$, $b_t \in B$, $a_t \in A$, and the realization of an aggregate productivity shock $z_t \in Z$ and financial shock $\theta_t \in \Theta$. Given the value of those five state variables, manufacturing firms choose among its control variables in order to maximize expected profits. Timing is as follows: At the beginning of a given period t, manufacturing firms are attached to a given supplier. They buy non durable input m_t from their suppliers at a price p. Suppliers require that at least a fraction $\underline{\phi}$ of the non durable input demand should be paid before production takes place. Since manufacturing firms do not have retained earnings, they have to find a way to make the payment in advance of at least $\underline{\phi} pm_t$. Attached firms delay this payment through uncollateralized debt a_{t+1}, one period bond debt at rate r_t^a provided by suppliers themselves. Manufacturing firms can choose to delay more payments, i.e. raise more uncollateralized debt, than the minimum fraction required by suppliers $\underline{\phi}$ if they wish to do so. Even if uncollateralized debt could be more expensive than collateral debt, firms constrained in its bank debt position could find optimal to raise additional trade debt to smooth dividends. They can delay up to the whole bill of the non durable input demand (suppliers will never lend to manufacturing firms for other purposes other than non durable good demand). Consequently the equations describing uncollateralized debt are (2) and (3)

$$\phi_t pm_t = a_{t+1} \quad (2)$$

$$\underline{\phi} \leq \phi_t \leq 1 \quad (3)$$

Equation (2) and (3) mean that manufacturing firms should raise at least as much uncollateralized debt a_{t+1} as $\underline{\phi} pm_t$. This idea is similar to a working capital constraint. There are however three main differences with the usual working capital constraint models. First of all, in this model uncollateralized credit a_t is an intertemporal debt paying an interest rate, whereas in most of the models the working capital is an intratemporal debt. Secondly, in this model suppliers have an important role determining how much uncollateralized credit is granted, whereas in most of the models the supply side of the working capital constraint is not well micro founded. And last, this payment in advance is an uncollateralized debt, while in models with endogenous collateral constraints and working capital, the working capital is also collateralized (Mendoza, 2008).

Rate r_{t+1}^a is determined through a Nash bargaining negotiation between the manufacturing firm and its supplier at the beginning of period t. The agreement point for manufacturing firm results on remaining attached to the current supplier. Then manufacturing firm uses uncollateralized debt to pay for the advance payment, and will pay in $t+1$ the corresponding rate r_{t+1}^a. The threat point results on detachment from the current supplier. From that point on, the manufacturing firm will meet a new supplier each period, to which it cannot be attached. These new suppliers still will require a payment in advance of $\underline{\phi} pm_t$. However they will not grant uncollateralized debt for it. If there is not a link between suppliers and manufacturing firms, there is not trust among them so no trade debt a_{t+1} is granted. This implies that detached manufacturing firms need to use bank debt to finance the advance payment $\underline{\phi} pm_t$. In other words, under threat point manufacturing firms need to collateralize the payment in advance. This implication is particularly painful for firms that are already binding on their bank debt. In case of getting detached, they should reduce drastically their bank debt position in order to leave room for the payment in advance. In addition, under threat point manufacturing firms pay a fixed cost each period cs_f, that represents the cost of searching a new supplier. It can also be seen as the cost of obtaining a less specialized product. In calibration section I impose a cs_f such that in equilibrium the surplus from the Nash Bargaining game is always positive. Consequently, in equilibrium an agreement is always reached. All manufacturing firm prefer to be attached to a supplier. Even big manufacturing firms, the ones that have access to additional bank debt, prefer to be attached and use trade debt to pay for $\underline{\phi} pm_t$. Otherwise they would have to search for a new supplier each period and this is expensive.

After obtaining m_t, the firm produces final good through $z_t F(m_t, k_t)$. At period t, durable input k_t has been obtained through investment in the previous period, i.e. capital is owned by firms and there is no capital rental market. Capital is subject to a convex adjustment cost. After production takes place, firms choose next period investment k_{t+1}, and pays back both bank debt b_t and trade debt a_t before distributing dividends d_t. I allow firms to distribute negative dividends, which can be seen as equity issuance. I include convex cost on dividends since equity issuance is costly and managers display a preference for dividends smoothing, as argued by Jermann and Quadrini (2012). Therefore, choices of capital k_{t+1} and dividends d_{t+1} display quadratic costs ψ_t^k and ψ_t^d such that

$$\psi_t^k(\bar{k}) = \gamma_k (k_t - \bar{k})^2 \quad (4)$$

$$\psi_t^d(\bar{d}) = \gamma_d(d_t - \bar{d})^2 \quad (5)$$

where $\bar{k}$ is the steady state level of capital, and calibration of $\bar{d}$ is discussed in section 2.4. At period t, an attached manufacturing firm solves the following problem:

$$v^a(a_t, b_t, k_t, z_t) = \max_{m_t, b_{t+1}, k_{t+1}, \phi_t} \left\{ d_t + \hat{v^a}(a_{t+1}, b_{t+1}, k_{t+1}, z_{t+1}) \right\}$$

$$d_t = z_t F(m_t, k_t) + (1-\delta)k_t + b_{t+1} + a_{t+1} - k_{t+1} - pm_t - a_t(1+r_t^a) - b_t(1+r_t^b) - \psi_t^k(\bar{k}) - \psi_t^d(\bar{d})$$
$$b_{t+1} \leq (1-\theta_t)k_{t+1}$$
$$\phi_t pm_t = a_{t+1}$$
$$\underline{\phi} \leq \phi_t \leq 1$$
$$\psi_t^k(\bar{k}) = \gamma_k(k_t - \bar{k})^2$$
$$\psi_t^d(\bar{d}) = \gamma_d(d_t - \bar{d})^2$$

$$\hat{v^a}(a_{t+1}, b_{t+1}, k_{t+1}, z_{t+1}) = \eta \mathbb{E}_t v^a(a_{t+1}, b_{t+1}, k_{t+1}, z_{t+1})$$

where η is the firm's discount factor. The value function of a manufacturing firm that was attached until period $t-1$ but gets unattached at t is v^u :

$$v^u(a_t, b_t, k_t, z_t) = \max_{m_t, debt_{t+1}, k_{t+1}} \left\{ d_t^u + \hat{v^{u2}}(debt_{t+1}, k_{t+1}, z_{t+1}) \right\}$$

$$v^{u2}(debt_t, k_t, z_t) = \max_{m_t, b_{t+1}, k_{t+1}} \left\{ d_t^u + \hat{v^{u2}}(debt_{t+1}, k_{t+1}, z_{t+1}) \right\}$$

$$d_t^{u1} = z_t F(m_t, k_t) + (1-\delta)k_t + debt_{t+1} - k_{t+1} - pm_t - a_t(1+r_t^a) - b_t(1+r_t^b) - \psi_t^k(\bar{k}) - \psi_t^d(\bar{d}) - cs_f \quad (7)$$
$$d_t^{u2} = z_t F(m_t, k_t) + (1-\delta)k_t + debt_{t+1} - k_{t+1} - pm_t - debt_t(1+r_t^{debt}) - \psi_t^k(\bar{k}) - \psi_t^d(\bar{d}) - cs_f \quad (8)$$
$$debt_{t+1} \leq (1-\theta)k_{t+1}$$
$$debt_t = b_t + \underline{\phi} pm_{t-1}$$
$$\psi_t^k(\bar{k}) = \gamma_k(k_{t+1} - \bar{k})^2$$
$$\psi_t^d(\bar{d}) = \gamma_d(d_{t+1}^u - \bar{d})^2$$

$$\hat{v^{u2}}(debt_{t+1}, k_{t+1}, z_{t+1}) = \eta \mathbb{E}_t v^{u2}(debt_{t+1}, k_{t+1}, z_{t+1})$$

where cs_f is the fixed cost of being unattached. Rate r_t^{debt} follows the same process as r_t^b, but taking into account that in threat point firms must collateralize also $\underline{\phi} pm_{t-1}$. Notice that if a manufacturing firm was attached to a supplier in $t-1$ but stops being attached in period t, the manufacturing firm still has to pay for the uncollateralized debt contracted on period $t-1$. This can be seen in d_t^{u1}, in which it does not appear the term a_{t+1} but it appears the term corresponding to the uncollateralized debt payment a_t. Also notice that once unattached, the manufacturing firm cannot obtain new uncollateralized debt a_{t+1}. Still it is required to pay $\underline{\phi} pm_t$ to the new supplier each period in advance. In order to make this payment, now the firm has to borrow it from the bank and consequently under threat point the payment in advance is also collateralized. Now, total collateralized debt, $debt_t$, is equal to the payment in advance $\underline{\phi} pm_t$ plus bank debt b_{t+1}.

2.3.2 Supplier

Suppliers' framework follows a simpler version of Fossati (2013). Suppliers are homogenous and can be attached or unattached to a manufacturing firm. In both cases suppliers pay a variable cost C^v per unit of non durable input that depends on aggregate productivity in the following way:

$C_t^v = \frac{C^f}{e^{z_t}}$

where z_t is the aggregate productivity, and where C_f is a fixed cost linear per unit of non durable input. This way suppliers are also linked to aggregate economic conditions. Price p is chosen a la Betrand so that in steady state all suppliers make zero profits. Consequently, p is equal to the fixed cost C_f. Notice that in presence of a negative productivity shock, suppliers will incur in a negative profit if they are attached to a manufacturing firm. Then they will try to increase the interest rate r_t^a in order to compensate the negative shock. The value function of a supplier that starts period t being attached to a manufacturing firm i is w^a:

$$w^a(z,i) = \left\{(p - C_t^v)m_t^i - \phi_t^i pm_t^i + (1 + r_t^a)\phi_{t-1}^i pm_{t-1}^i + \eta^s \mathbb{E}_t w^a(z,i)\right\}$$

where z and i are the state variables for the supplier, η^s is the discount factor of the supplier firm, and m_t^i, ϕ_t^i are the choices of non durable goods and trade debt of its client, the manufacturing firm i.

The supplier is willing to fulfill the non durable input demand of its client, but requires that at least a fraction $\underline{\phi}$ of the non durable demand should be paid in advance. Next, it negotiates the price of trade debt r^a_{t+1} through a Nash Bargaining negotiation with the manufacturing firm. A bargaining agreement results on remaining attached to the manufacturing firm i during the rest of t, lending uncollateralized debt to it and obtaining the repayment on $t+1$. The threat point for not reaching an agreement is that the supplier gets unattached from firm i, and then exits the market. The value function of a supplier that was attached until period $t-1$ but gets unattached at t is w^u :

$$w^u = \left\{(p - C_v)m^j + \phi^i_{t-1} p m^i_{t-1} + \eta^s w^{u2}\right\}$$

$$w^{u2} = 0$$

Notice that if a supplier gets unattached at the beginning of period t, still gets from firm i the uncollateralized debt payment, $\phi^i_{t-1} p m^i_{t-1}$. I do not allow for default on uncollateralized debt. Once the supplier gets unattached, it exits the market. Therefore $w^{u2} = 0$.

The supplier's surplus from the Nash Bargaining game is $\Delta^s = w^a - w^u$. The manufacturing firms' surplus from the Nash Bargaining game is $\Delta^m = v^a - v^u$. The rate of trade debt bonds r^a_{t+1} is decided each period according to the following standard Nash Bargaining game:

$$r^a_{t+1} = argmax\left[(\Delta^s)^{\kappa}(\Delta^m)^{1-\kappa}\right]$$
$$\text{st } \Delta^s \geq 0$$
$$\Delta^m \geq 0$$

where κ denotes the bargaining power of the manufacturing firm, and $1-\kappa$ the bargaining power of the supplier. In steady state, if I allow manufacturing firms to have all the bargaining power, then r^a would be equal to $\frac{1}{\eta^s}$. Suppliers would never accept a rate of $\frac{1}{\eta^s}$ or below since then they would incur in negative profits, and would never oblige manufacturing firms to ask for trade debt. On the other hand, if suppliers have all the bargaining power, they would set trade debt rate as high as possible. Depending on the value of r^a_t, in steady state manufacturing firms would be binding or not on their choice of trade debt ϕ_t. This depends on the discount factors of suppliers and manufacturing firms.

Proposition 1: *In steady state, all firms would be binding on its trade debt, i.e.* $\phi_t = \underline{\phi}$, *if* $\eta^s \leq \eta$

This is true even if κ approaches to one. From the first order condition of the choice of trade debt ϕ_t:

$$\varsigma_t m_t p = \eta \varsigma_{t+1} m_t p(1 + r_t^a) - \mu_t$$

where μ_t is the multiplier associated with the lower bound of the occasionally constraint (3), the one regarding trade debt, and ς_t the multiplier associated with the resource constraint. If manufacturing firms have all the bargaining power, $(1 + r_t^a)$ will be at its lower bound value in steady state, $\frac{1}{\eta^s}$. This implies that the multiplier on trade debt will be zero only if manufacturing firms have all the bargaining power and $\eta^s = \eta$. Otherwise, trade debt rates will result on a cost, and μ_t will be bigger than zero in steady state for all manufacturing firms. In my calibration I set the same discount factor for manufacturing firms and suppliers, and I do robustness checks for different Nash bargaining coefficients in the appendix. In any case, all firms are binding on its trade debt in steady state.

2.3.3 Financial intermediary

There exists a representative financial intermediary that lends collateral debt to the manufacturing firms. It lends inelastically and charges an interest rate to the manufacturing firms according to

$$r_t^b = r^b + \frac{\gamma_b (b_{t+1} - \bar{b})^2}{2} \qquad (5)$$

where r^b is a risk free rate and $\bar{b}$ could be interpreted as the optimal amount of borrowing. It is an exogenous value that I impose, and it determines which fraction of firms is binding on collateral debt on steady state. I set its value in section 2.4. This interest process is an ad hoc way of capturing the idea that smaller firms pay a higher bank interest rate and are more likely to be credit constraint that its bigger counterparts. Bank interest rates will be higher than the risk free rate if the manufacturing firms demand's for loans is different than $\bar{b}$. This implies a threshold size $\widetilde{k}$ dependent on $\bar{b}$ below which manufacturing firms will be binding on the collateral constraint and will pay a higher bank interest rate than r^b in steady state:

Proposition 2: *In steady state, firms with* $(1-\theta)\bar{k} < \bar{b}$ *will be binding on its bank debt if* $(1+r^b)\eta < 1$

where $\bar{k}$ is the steady state level for capital. From the first order condition of bank debt b_{t+1}:

$$\varsigma_t = \lambda_t + \varsigma_{t+1}\eta \left\{(1 + r_t^b) + \gamma_b(b_{t+1} - \bar{b})b_t\right\}$$

where ς_t is the multiplier of the resource constraint, and λ_t the multiplier of the bank debt constraint. In steady state, if $(1-\theta)\bar{k} < \bar{b}$ then b_{t+1} will be less than $\bar{b}$. Therefore, λ_t is positive and those firms will be binding on their bank debt collateral constraint and paying an interest rate higher than the risk free rate in the steady state. For these manufacturing firms, marginal gains from more bank debt are bigger than the costs, despite the higher r_t^b. This way they could get closer to the bliss demand point $\bar{b}$. On the other hand, firms with sufficient capital optimally choose an amount of bank debt b_{t+1} such that $\lambda_t = 0$ and $r_t^b = r^b$. The fact that big firms choose a level of debt such that they are not binding in steady state is consistent with Khan and Tomas (2013). In that model, bigger firms choose a debt schedule such that they will never become binding again, and smaller firms are binding on their collateral constraint until they grow big enough. Also, the result that smaller firms pay a higher bank interest rate is consistent with the evidence showed in "Boletín Económico Banco de España" 2014. Loans under 1 million euros imply a higher interest rate than loans over 1 million euros. Difference between these two interest rates can be considered a proxy of how expensive is borrowing for small and medium firms from banks, and the latter can be considered a proxy of how expensive it is for bigger firms. Moreover, this gap has widened during the crisis. This data is showed in the appendix, section 2.7.2.

The model is calibrated so $(1 + r^b)\eta < 1$. Proposition 2 implies that firms below certain $\widetilde{k}$ threshold will be binding on their bank debt position: If $\bar{k} \leq \widetilde{k}$ then $b = (1-\theta)\bar{k}$ in steady state. Firms can temporally switch the regime in presence of a sufficiently big shock. In presence of a negative shock to productivity, firms binding on their bank debt position in steady state will continue being binding. On the other hand, firms that are not binding in its bank level in steady state, i.e. firms $\bar{k} \geq \widetilde{k}$, could become temporally binding after a negative aggregate productivity shock. This can happen for firms bigger than $\widetilde{k}$ but by a small margin. A negative financial shock affecting θ_t yields the same dynamics.

2.4 Calibration

Periods in the model are quarters. Most of the parameters follow a standard calibration. I set β=0.9825, δ=0.025, and $r^b = 0.01$. The coefficients for the production function follow the usual values for labor and capital share, α_m=0.6 and α_k=0.3. The adjustment cost of dividends is set to $\gamma_d = \frac{1}{7.14}$ as in Jermann and Quadrini (2012). For the adjustment cost of capital I use the estimate of Schmitt-Grohé and Uribe (2012), $\gamma_k = \frac{1}{0.42}$, since their specification of the adjustment cost is very similar to mine. Results do not change much if I set the adjustment cost over a robust interval $\gamma_k \in [\frac{1}{3}, \frac{1}{0.3}]$. For the adjustment cost of debt in the bank interest rate process, I test my exercises with different values γ_b. Main results are very robust to a wide range of possibilities. According to the literature of finance over the business cycle, debt has a tax advantage over equity (negative dividends here), so for the moment I consider values of γ_b that imply less costly movements than equity, values that satisfy $\gamma_b \leq \gamma_d$. I use $\gamma_b = \frac{1}{50}$, and I perform additional robustness checks for $\gamma_b \in [\frac{1}{10}, \frac{1}{100}]$ in the appendix, section 2.7.4. Parameters θ and $\underline{\phi}$ are calibrated to match respectively an average of 20% of bank debt over assets for small/medium firms, and an average of 15% of trade debt over assets for all firms. I control the size of the firm with $\bar{k}$. Range of sizes goes from the smallest firm $\bar{k} = 10$, that corresponds to firms with 10 employees, to firms with $\bar{k} = 40$ that corresponds to the biggest firm. I consider big firms the ones that do not become binding after a productivity and a financial shock, which in my model means firms above $\bar{k}$=35. I regard as small firms the ones with $\bar{k} \in [10, 25)$, medium firms the ones with $\bar{k} \in [25, 35)$, and big firms $\bar{k} \in [35, 40]$. I set $\bar{b}$ to 7 so threshold $\widetilde{k} = 29$. Recall that firms with a steady state level of capital below this threshold will be binding in its collateral constraint in steady state. This implies that the biggest firms among those with medium size are non binding on bank debt position on steady state. However, these firms are not big enough and could become temporally bank binding after a sufficiently negative productivity or financial shock. With $\bar{b}$ I control the fraction of firms that are binding on the collateral constraint in steady state. Changing this value do not change the main results of the model. Calibration is such that in steady state $r^a \in [1.035, 1.045]$, so trade debt implies a cost for manufacturing firms. All firms are binding on steady state on the lower bound of $\phi_t = \underline{\phi}$. But still in presence of a bad negative shock, manufacturing firms are likely to increase trade debt. Fixed cost for suppliers C_f and Nash Bargaining coefficient κ are fixed to 0.5 arbitrarily. Fixed cost of threat point for manufacturing firms cs_f is fixed to 0.01. In appendix, section 2.7.4, I perform sensitivity analysis for these parameters. Different values for these three parameters do not change my main conclusions. Last, special mention to $\bar{d}$. In this model manufacturing firms are not allowed to retain earnings. Consequently, in order to discipline dividends d_t with real data, I will use return to assets ratio (ROA). ROA is equal to

$\frac{NetIncome}{TotalAssets}$, and according to “Ministerio de Industria, Energía y Comercio de España”, average ROA in manufacturing sector in year 2015 is 12%. That will imply that dividends in steady state should be around $\frac{\bar{k}}{8}$. Consequently, I choose $\bar{d} = \frac{\bar{k}}{8}$, capturing with ψ^d the idea that if firms distribute too many dividends or too much equity, an underlying cost should be paid. This can be thought as an institutional friction.

The processes regarding the shocks are:

$z_t = \rho z_{t-1} + \sigma \epsilon_t$

$\theta_t = \theta + \rho^b \theta_{t-1} + 0.5 zz_t$

$zz_t = \rho zz_{t-1} + \sigma^b \epsilon_t^b$

Where $\rho = \rho^b = 0.9$, $\sigma = \sigma^b = 1$. The aggregate productivity shock will be a negative shock to ϵ_t and the financial shock will be a positive shock to ϵ_t^b. This particular process for θ_t has been chosen so bank debt for smaller firms reacts in line with data. After the realization of the financial shock, it takes some time to bank debt to decrease. It reaches its lower peak 8 quarters after the beginning of the crisis. This is consistent with empirical evidence on bank debt, figure 35. Calibration is summarized in table 30.

α_m	α_k	ρ	ρ_b	σ	σ^b	r_b	η	δ	θ
0.6	0.3	0.9	0.9	1	1	0.01	0.9825	0.025	0.75
γ_b	γ_k	γ_d	$\bar{b}$	κ	$\underline{\phi}$	c_f	$\bar{d}$	cs_f	
$\frac{1}{50}$	$\frac{1}{0.42}$	$\frac{1}{7.14}$	7	0.5	0.4	0.5	$\frac{\bar{k}}{8}$	0.01	

Table 23: Calibration

2.5 Results

In this section I focus on the steady state results, and on the responses of the model to productivity and financial shocks. I seek to replicate the empirical facts described in section 2.2: The observed fall of total leverage by smaller firms, the dynamics of short other debt and bank debt for firms of different sizes, and the rise in interest rates of both debt instruments. In part 5.1 I explain which solution method is used. In 5.2 I present the steady state results, and in sections 2.5.3 and 2.5.4 the impulse response functions under two different scenarios.

2.5.1 Solution method

I solve the model using Occbin, a toolkit for Dynare by Guerrieri and Iacoviello (2015) that adapts the first order approximation approach and applies it in a piecewise fashion to solve dynamic models with occasionally binding constraints. The problem is handled as different regimes of the same model: Reference regime vs alternative regimes. Under one regime, some constraints could be binding in steady state. Under the other regime, the constraints will behave differently. It is a convenient method since allows applicability to models with large number of state variables. Firms will be initially on a reference regime. Then I impose two exogenous shocks, to aggregate productivity ϵ_t and to financial conditions ϵ_t^e. After the realization of the shocks, firms might or might not move from the reference regime. One of the main weaknesses of this method is that, by assumption, if shocks move the model away from the reference regime to the alternative regime, the model will return to the reference regime in a finite amount of time under the assumption that agents expect that no future shocks will occur. On the other hand, as argued by Guerrieri and Iacoviello, the policy functions retrieved by OccBin are close to the fully non linear policy functions from highly accurate projection methods.

Before proceeding to the results, I define clearly the possible regimes. Taking into account my set up, there are four possible situations according to the occasionally binding constraints. These possibilities are displayed on table 24.

Regime 00	Regime 01	Regime 10	Regime 11
$b_{t+1} = (1-\theta)k_{t+1}$	$b_{t+1} = (1-\theta)k_{t+1}$	$b_{t+1} < (1-\theta)k_{t+1}$	$b_{t+1} < (1-\theta)k_{t+1}$
$\underline{\phi} = \phi_t$	$\underline{\phi} < \phi_t$	$\underline{\phi} = \phi_t$	$\underline{\phi} < \phi_t$

Table 24: Possible regimes

By proposition 1 I can disregard two regimes on the steady state, regime 01 and regime 11, since ϕ_t will never bigger than $\underline{\phi}$ in steady state for any firm. In addition, by proposition 2, firms with a steady state size $\bar{k}$ lower than $\widetilde{k}$ are binding on their steady state in the bank collateral constraint. Consequently I consider two references regimes on steady state: Regime 00, and Regime 10. Firms with less than $\bar{k} < \widetilde{k}$ are binding on their bank debt on steady state. Their reference regime is 00. Firms with such that $\bar{k} \geq \widetilde{k}$ are not be binding on their bank debt constraint on steady state. Their reference regime is 10. Recall that in presence of a sufficiently big shock, firms could switch temporally from one regime to another.

2.5.2 Steady state

I display in table 25 the results for firms of different sizes: $\bar{k}$=10, 15, 20, 25, 20, 35 and 40. Firms with 28 would be just binding on their bank debt position, and firms with 29 are on the edge of being binding.

k_{stst}	10	15	20	25	30	35	40
b_t/k_t	0.20	0.20	0.20	0.20	0.19	0.16	0.13
a_t/k_t	0.17	0.15	0.14	0.13	0.13	0.12	0.12
m_t/k_t	0.85	0.79	0.73	0.69	0.67	0.64	0.62
Total $leverage_t/k_t$	0.37	0.35	0.34	0.33	0.32	0.28	0.25
r^a	1.04	1.04	1.04	1.04	1.03	1.03	1.03
r^b	1.18	1.11	1.04	1.01	1.01	1.01	1.01

Table 25: Steady state results

Table 26 shows moments of relevant variables from data and from the model. I compare my model's steady state results with data on 2007, the year before crisis started. Bank debt percentage for small and medium firms is 20% since I calibrated the collateral constraint parameter to obtain that level. My model is able to capture the level of bank debt for big firms and the negative correlation between bank debt and size, as in table 19 and figure 35. I also manage to replicate the negative correlation for trade debt and size as in the data, table 21. Consequently pre crisis correlation between different kinds of credit and size is well captured. Total debt is smaller in the data than in the model. In my model total debt is between 35% for small firms to 26% for the big firms. In the data is between 60% and 55%. This is due to the fact that I do not take into account bonds (long term uncollateralized debt) and that in my model I only consider trade debt (which is around half of all short other debt).

	Data 2007	Model Steady State
Trade debt small firms	0.19	0.15
Trade debt medium firms	0.18	0.14
Trade debt large firms	0.13	0.12
Bank debt small firms	0.20	0.20
Bank debt medium firms	0.20	0.19
Bank debt large firms	0.12	0.13

Table 26: Model vs data

2.5.3 Response to a productivity shock and financial shock. Benchmark model

In this section I assess how firms of different sizes respond to a productivity shock and a financial shock. Productivity shock would consist on a 3% decrease of ϵ_t, and the financial shock would be a 1.5% increase on ϵ_t^b. Impulse response functions are shown for 40 quarters, and shocks occur simultaneously in period 10. For all firms I show the response of non durable input m_t, investment k_{t+1}, collateral debt percentage $\frac{b_t}{k_t}$, trade debt percentage $\frac{a_t}{k_t}$, uncollateralized debt interest rate r_t^a, dividends d_t and total leverage percentage $\frac{b_t+a_t}{k_t}$. Responses will be shown in percentage deviations from steady state for collateral debt, uncollateralized debt, dividends, non durable and durable demand. For uncollateralized debt interest rate and total leverage that I show deviations in levels. Recall that I consider small firms those with $\bar{k} = [11, 25]$, medium size firms the ones with $\bar{k} = [25, 35)$, and big ones above $\bar{k} = 35$. First I show the results for the benchmark model.

Analysis for $\bar{k} = 20$, $\bar{k}$ =28, firms that are in regime 00 in steady state

In figure 38 I show responses for a firm with $\bar{k} = 20$ in blue line, and $\bar{k} = 28$ in red dotted line. Both firms start from regime 00, $b_{t+1} = (1-\theta)k_{t+1}$ and $\underline{\phi} = \phi_t$. Firm with $\bar{k} = 20$ is representative of small firms, and firm with $\bar{k} = 28$ is representative for medium size firms that start binding on their bank collateral constraint, the smallest among the subset of medium size firms. The most important response is the one for variable r_t^a, the uncollateralized debt interest rate. Notice on the top right of figure 38 that the steady state level of the rate is almost the same for both representative firms. In period ten, after the realization of the shocks, there is a huge increase of r_t^a. This is due to the fact that these two firms are eager for more funds after the shocks. Both are binding on the collateral constraint, so their only chance to obtain more funds after the realization of the shock is through the supplier. The supplier can extract a surplus from the manufacturing firm and impose a higher r_t^a. Interest rate increases more for medium size firm because this firm is more binding on the collateral constraint. The medium size firm is very close to optimal amount of borrowing $\bar{b}$, so its steady state interest rate on collateral debt is very close to the risk free rate $r^b = 1.011$. However, the small firm is not so binding because collateral debt implies a tradeoff for them. On the one hand, more collateral debt will make them closer to the optimal amount of borrowing $\bar{b}$, but its steady state interest rate on collateral debt is high, $r^b = 1.042$. Then, firm $\bar{k} = 20$ is not so willing to take more collateral funds, and it is not so much binding on their collateral constraint. Suppliers extract a lower surplus from them.

Non durable demand, top left of figure 38, decreases for two reasons. First, it decreases because the aggregate productivity negative shock. Secondly, because uncollateralized debt interest rates imply an enormous extra cost for the non durable input demand. The drop in non durable demand of the medium size firm is more severe than the one of the small size firm, because medium size firm experience a higher rise in trade debt interest rate. Since $\phi_t p m_t = a_{t+1}$, this translates into a bigger drop of uncollateralized debt for medium size firms. This sudden drop is similar to the observed in short other leverage in the data, figures 36 and 37. The dynamics of collateral debt are the same for both firms. Both are binding on their collateral debt for the period analyzed, so bank debt b_{t+1} just moves according to the process I impose to θ_t. This process is such that small and medium size firms experience a progressive decrease in bank debt after the shocks, similar to the one observed in the data, figures 35 and 37.

All these events translates into a decrease of dividends and a deleverage process as it can be seen on the bottom of figure 38. Both the decrease of dividends and the deleverage process are more intense for medium size firms since the uncollateralized debt implies a higher extra cost. This deleverage process is in line with the one observed in the data, figure 34 and table 18.

Analysis for $\bar{k} = 29$, $\bar{k}$ =35, firms that are in regime 10 in steady state

In figure 39 I show responses for a firm with $\bar{k} = 29$ in blue line, and $\bar{k} = 35$ in red dotted line. Both firms start from regime 10, i.e. $b < (1 - \theta)k$ and $\underline{\phi} = \phi$. Firm $\bar{k} = 29$ is representative of medium size firms that start non binding on collateral constraint, and firm with with $\bar{k} = 35$ is representative for big firms. Firm $\bar{k} = 29$ is not binding on its collateral constraint on steady state by a small margin. It has just sufficient capital to be non binding and obtain optimal amount of borrowing $\bar{b}$. After the realization of the shocks, medium size firm becomes temporally binding on the collateral constraint. It cannot obtain more bank debt since it becomes binding, and then the supplier can extract surplus from the bargaining. Therefore interest rate of uncollateralized debt increases much more for medium size firm. Firm $\bar{k} = 35$ is big enough so that never become binding after the shock in the collateral constraint. The possibility of getting additional finance prevents the supplier from increasing much the uncollateralized debt interest rates.

Again, trade debt is an extra cost for medium size firms in the benchmark model. This extra cost can be appreciated in the response of non durable demand. As in the analysis for $\bar{k} = (20, 28)$, non durable demand was going to decrease anyway because the aggregate negative productivity shock. But the decrease is much more severe for medium size firm due to the higher extra cost of r_t^a. This translates into a higher decrease of trade debt by medium firms than for big firms, which is in line with the second empirical fact.

Collateral debt behaves very differently for medium and big firms. Medium size firm becomes binding after the realization of the shock, so b_{t+1} just evolves according to the process I impose to θ_t, as the rest of medium firms and small firms. Big firms however are slack in the collateral constraint and find optimal to increase bank debt by more than 2%. This is similar to empirical evidence from figure 37.

All these events have as a consequence a bigger drop in dividends and total leverage by medium size firm with respect to big firm, as predicted in the data. Big firms' ability to interchange one kind of debt by another allow them to smooth better the real effects of a productivity and a financial shock. In figure 40 I plot the responses for the big firm alone. This way it can be appreciated better the dynamics for big firms.

2.5.4 Response to a productivity shock and financial shock. Counterfactual

In this section I show the results for a counterfactual experiment, in which trade debt conditions for manufacturing firms are better than in the benchmark exercise. I analyze the dynamics of a medium size firm $\bar{k} = 28$ and a big firm $\bar{k} = 35$ that have access to trade debt at a low and constant interest rate r^a=1.02. This rate is lower than the steady state rate of $\bar{k} = 28$ and $\bar{k} = 35$, 1'04 and 1'03 respectively.

Analysis for $\bar{k} = 28$, firm that is in regime 00 in steady state

In figure 41 I show the response in the counterfactual experiment of a firm with steady state size $\bar{k} = 28$, a medium size firm that is binding on its collateral constraint in steady state. In blue line I represent the counterfactual response, and in red dotted line the benchmark response. First notice that uncollateralized debt rate does not increase in the counterfactual experiment, because it is fixed for the whole period. This can be interpreted as a counterfactual world in which trade debt conditions do not get worse during the crisis and are slightly better than in steady state. The main consequence is that now trade debt is not an extra cost for the non durable demand anymore. Non durable demand decreases in the counterfactual world as consequence of the negative aggregate productivity shock. However, the drop in non durable demand is much less severe in the counterfactual world than in the benchmark model, in which trade debt represents an extra cost for small and medium firms. Also notice that uncollateralized debt behaves in a different way with respect the benchmark exercise. In the counterfactual world, smaller firms find optimal to increase their uncollateralized demand, i.e. increase ϕ_t in order to smooth consequences of the shocks. The medium size firm jumps temporally from regime 00 to regime 01, because $\phi_t > \underline{\phi}$ for some periods. To recap, keeping constant and low the trade debt conditions allows medium size firms to increase trade debt. This way, medium size firms are able to smooth much better dividends and even avoid total deleverage, in contrast with the benchmark exercise. Under these conditions, trade debt is a source of extra liquidity, as argued in Cunyat (2007). The result from this analysis can also be applied to smaller firms.

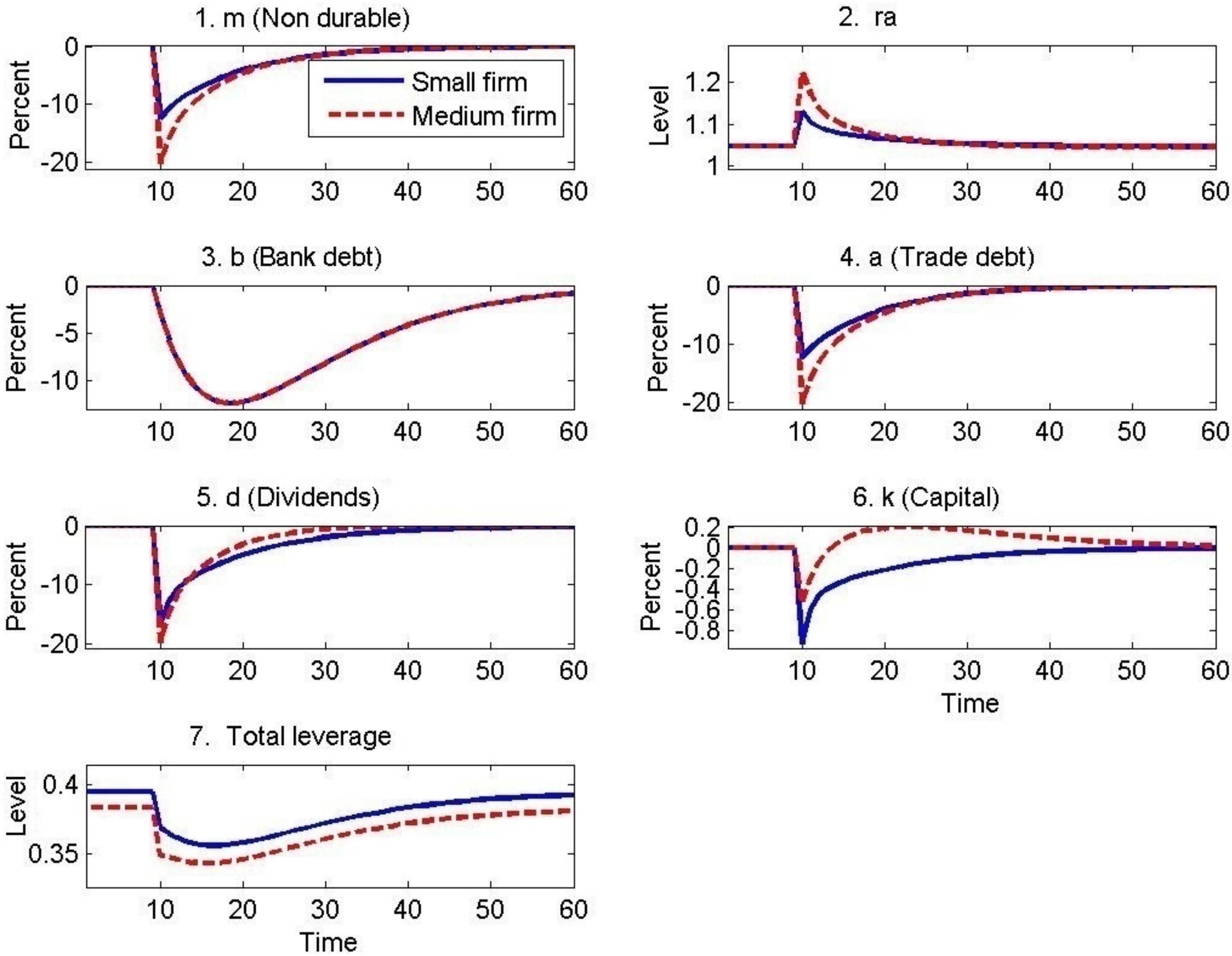


Figure 38: Impulse response functions for small and medium firms. $\bar{k}$=20, 28

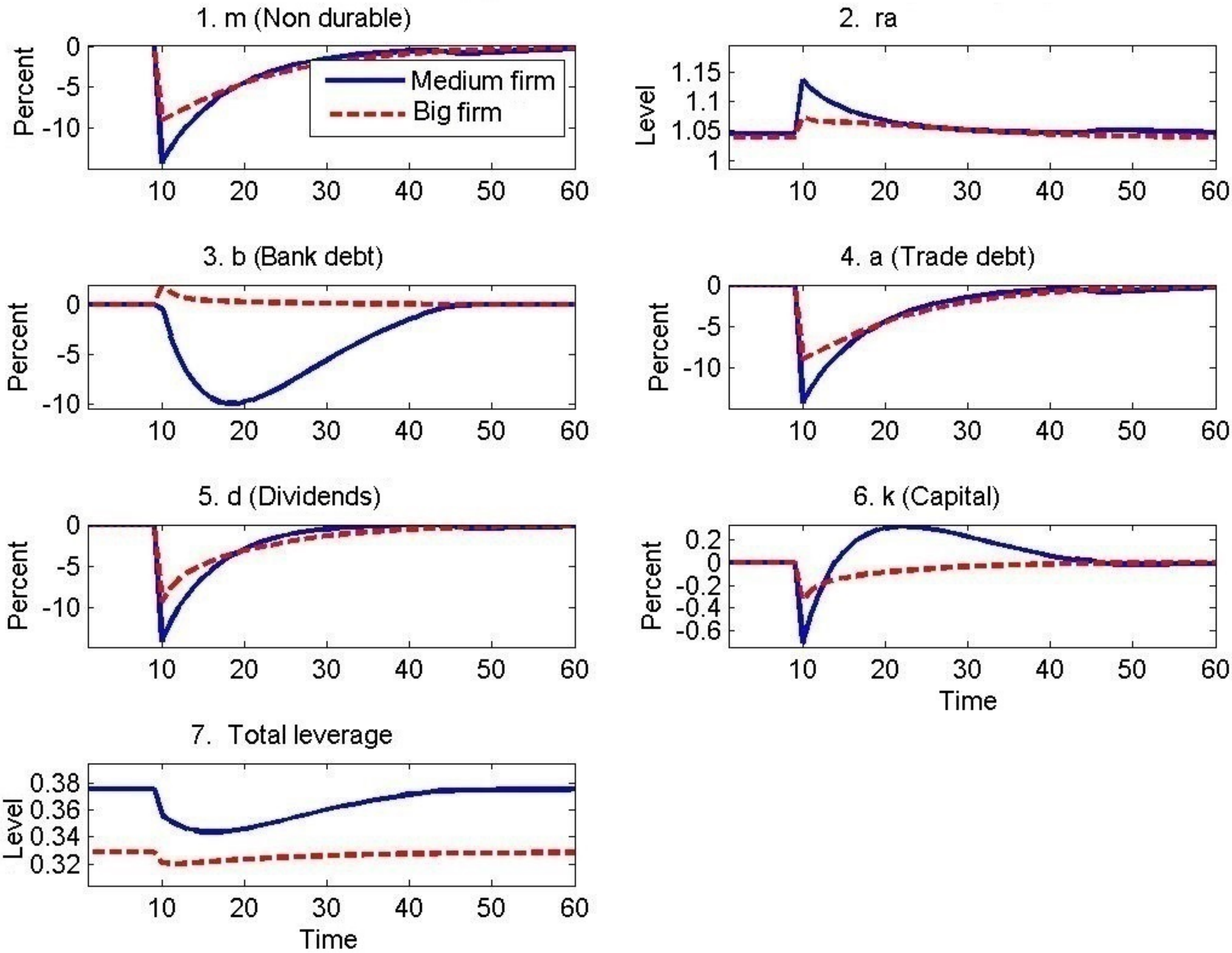


Figure 39: Impulse response functions for medium and big firms. $\bar{k}$=29, 35

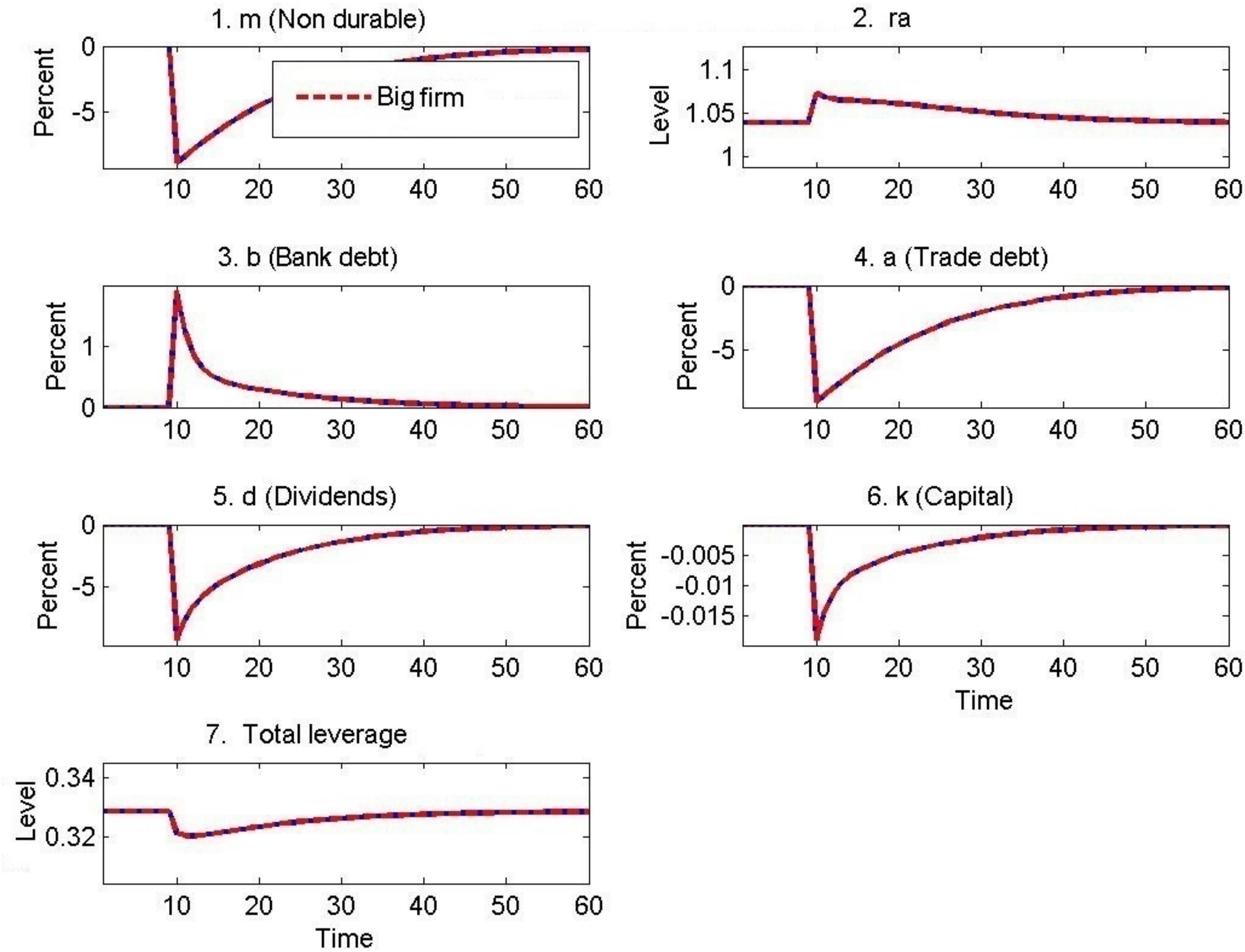


Figure 40: Impulse response functions for big firms. $\bar{k}$=35

Analysis for $\bar{k} = 35$*, firm that is in regime 10 in steady state*

In figure 42 I show the response in the counterfactual experiment of a firm with steady state size $\bar{k} = 35$, a big size firm. It can be seen that big firms' performance under the counterfactual world also improves with respect the benchmark model, but the improvement is not as important as it is for medium size firms. Under the counterfactual scenario, big firms do not use more trade debt since they can still increase their bank debt position which remains cheaper. The slight improvement comes from the fact that trade debt does not imply an extra cost for the non durable demand.

2.6 Conclusions

This paper is motivated by two facts from the 2008 crisis. First of all, from 2008 to 2012 big firms managed to keep debt constant, while smaller ones deleveraged. Secondly, big firms managed to keep debt constant because they managed to interchange bank debt and other debt more efficiently. I built a quantitative macroeconomic model that can replicate these facts. The implications are relevant since I demonstrate that the ability to interchange bank debt and trade debt matters for firms' growth and dividend smoothing. There is a gap in the literature about firms' ability to interchange bank debt and trade debt. Most of the literature focuses on bank debt, thus underestimating the real effects of financial crises and leading to misleading policy implications. There is recent literature focusing on trade debt, but it does not account for substitution between bank debt and trade debt and worsening trade debt conditions for small firms. My model is able to replicate both facts, and the fact that trade credit conditions during the 2008 crisis were better for big firms. After a productivity shock and a financial shock, big firms have the possibility to raise more bank debt. Therefore they are able to obtain better terms with the supplier than their smaller counterparts. Small and medium firms experience a worsening in trade debt conditions, and trade debt ends being an extra cost rather than a source of extra liquidity, as data from last crisis suggest. I show in a counterfactual experiment that keeping trade debt conditions low and constant during crisis is especially important for small and medium firms. This way they have access to additional finance and liquidity. In this counterfactual experiment smaller firms manage to mitigate the real effects of a crisis as good as big firms.

This paper open doors to extend my model to a general equilibrium framework with heterogeneous firms. This way it could be studied how the ability to interchange different kinds of debt can change the distribution of firms. Also, extending my model to a general equilibrium framework will allow to

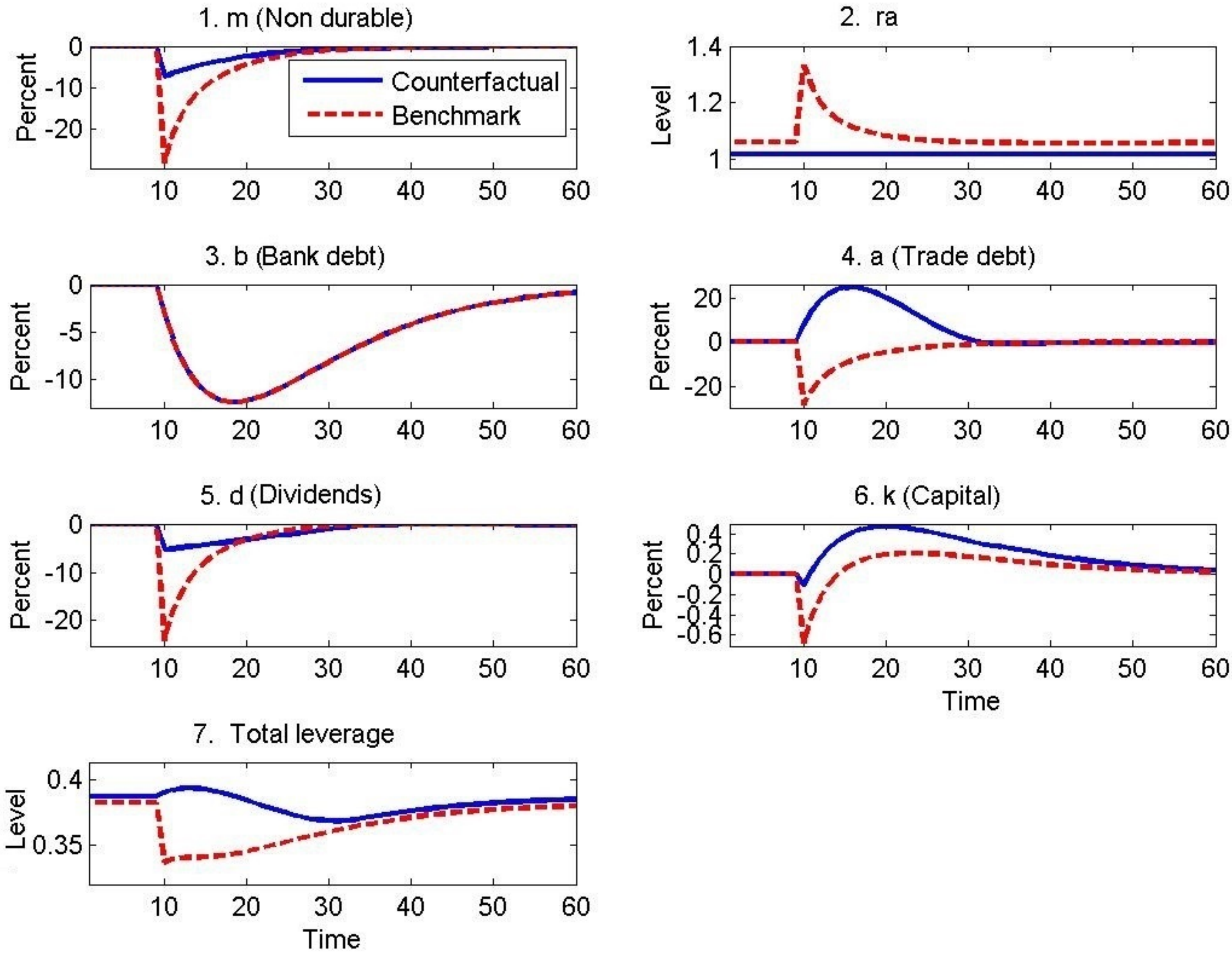


Figure 41: Impulse response functions for medium firms. Counterfactual

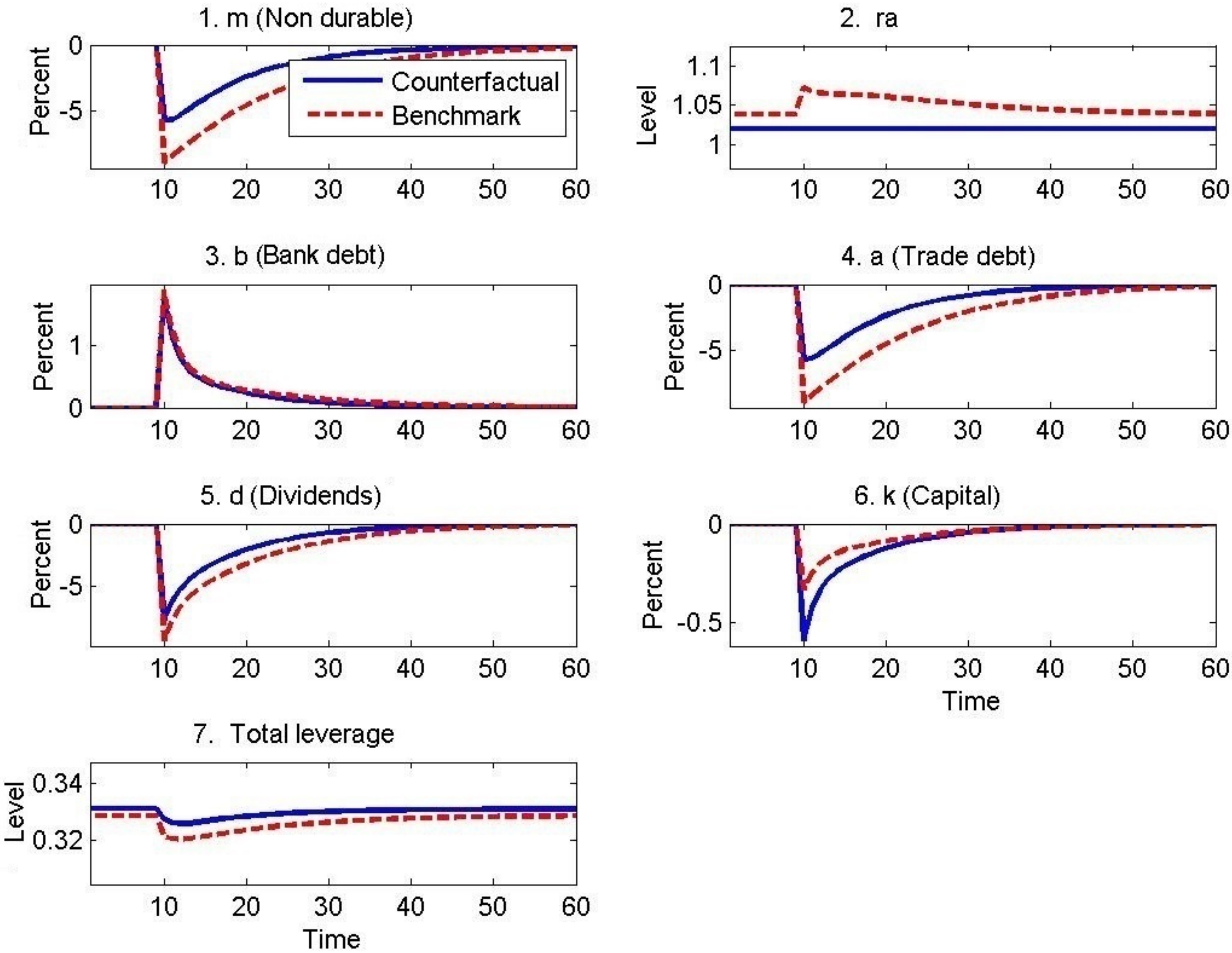


Figure 42: Impulse response functions for big firms. Counterfactual

study which policies could keep trade conditions favorable for small firms.

2.7 Appendix

2.7.1 Definition of variables

Total leverage: It is a % computed as liabilities (amount of obligations/credits of the firm), divided by liabilities and amount of owner's equity. I distinguish between Bank leverage and Other leverage. Total leverage = Bank leverage + Other leverage

Bank leverage: It is a % computed as amount of credit owned to financial institutions divided by total leverage. Includes short (to pay in less than a year) and long (to pay in a year) credit

Other leverage: It is a % computed as amount of non financial credit divided by total leverage. Includes short and long credit. Other leverage is composed by suppliers, other creditors, advanced payments from clients, pending personal payments, loans from public administrations, anticipated revenue, operating allowances, debt securities and other similar liabilities, debts with own group companies, debt from non financial companies , other non financial accounts and interest collected in advance.

Sales growth: Log growth of sales.

Employment: Total number of employees.

Investment: It is computed as acquisitions and reparations of equipment, industrial machinery, furniture and fixed capital over sales.

Temporal employment: % of temporal workers over total workers

Age: Current year minus the year of foundation

Size: Logarithm of total assets.

Current assets: % of current assets over total assets

Industries

There are 20 possible manufacturing industries in Spain

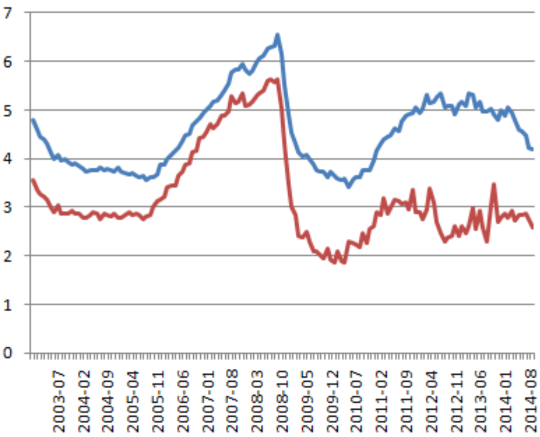
1. Meat industry
2. Food products and tobacco
3. Beverages
4. Textiles

5. Leather and shoes
6. Wood
7. Paper industry
8. Printing
9. Chemicals and pharmaceutics
10. Rubber and plastic
11. Non metallic minerals
12. Ferrous metals
13. Metal products
14. Agricultural and industrial machinery
15. Computer, electronic and optical product
16. Electric machinery and equipment
17. Motor vehicles
18. Other transport equipment
19. Furniture
20. Other manufacturing services

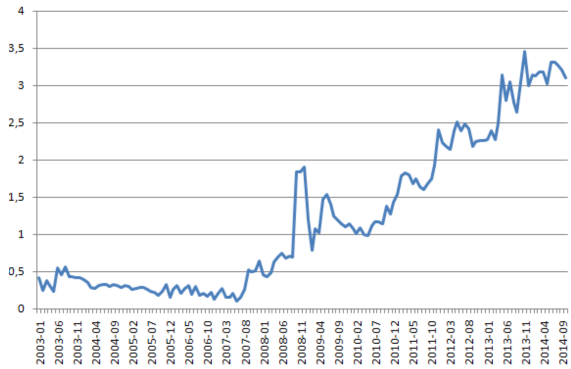
2.7.2 Bank interest rates in Spain

Figure 43a represents the evolution of interest rates of loans from credit institutions to non financial firms in Spain from 2003 to 2014. Blue line represents average interest rates of credits below one million euros. Red line represents average interest rates of credits over one million euros. The former can be considered as a proxy of how expensive is borrowing for small and medium firms from banks, and the latter can be considered a proxy of how expensive it is for bigger firms. Figure 43a shows that for the whole sample, interest rates are always higher for smaller firms. Also, this gap became bigger during the crisis. From 2005 until October 2008, interest rates of loans from credit institutions increased a lot for both credits up to one million and credits over one million. In October 2008, BCE decreased reference interest rates from 5.25 to 4.25, and by May 2009 to 1.75. These drops were partially transmitted to the rates at which banks were lending to non financial firms. However, a wide gap was created between interest rates of credits up to one million and interest rates of credits over one million. That gap has been not closed. In fact, it got bigger during the crisis, as further decreases in the ECB lending rates were not transmitted to private rates. The failure in this transmission seems to affect more severely to small and medium firms.

In order to understand better the failure in the transmission, in figure 43b I show the differential between ECB reference lending rates and average interest rate from credits institutions to non financial firms in Spain. Before the crisis, the differential was very small, below 0.5%. The intense decrease of ECB interest rates from October 2008 to May 2009 was transmitted partially to private rates, so the differential grew until 1%. But from May 2010 onwards, further decreases of ECB interest rates were not transmitted at all to private rates, so the gap between ECB rates and privates rates increased a lot during the rest of the crisis (until 3.5%). This differential seems to affect more to small firms, as the gap between credits below one million euros and credits over one million also increased. This evolution of prices is more consistent with the story that says that in Spain there is a supply shock.



(a) Spain: Rates up to and over 1 million



(b) Private rates vs ECB rates, Spain

Figure 43: Private interest rates and ECB rates

In addition, we can see that in Spain the situation is worse than in the Eurozone. In figure 44a I represent interest rates below one million for Spain (red) and for Eurozone (blue). In figure 44b I represent interest rates above one million for Spain (red) and for Eurozone (blue). In both cases, before the crisis Spanish firms were borrowing at the same rate as the rest of their counterparts in Europe. However, after the crisis, interest rates for Spanish firms become higher than in the rest of the Eurozone. This gap is bigger for smaller Spanish firms, as it can be seen in figure 44a.

(a) Spain vs Europe: Rates up 1 million

(b) Spain vs Europe: Rates over 1 million

Figure 44: Private interest rates. Spain and Europe

2.7.3 Variance decomposition

In table 27 I present the variance decomposition for different firms' sizes. Recall that firms below $\bar{k} = 28$ are binding on the collateral constraint on the steady state.

2.7.4 Robustness checks

Robustness with parameter γ_b:

Both benchmark and counterfactual exercises of section 2.5 have been done under the assumption that $\gamma_b = \frac{1}{50}$. In this section I show how do the model react to changes in the parameter governing the cost of raising bank debt. It does not change almost anything the dynamics of the firms that are binding on the collateral constraint in the steady state. This is due to the fact that for those firms, bank debt dynamics are driven by the collateral constraint and the movements in θ_t. But γ_b can have a big effect for bigger firms, the ones that are not binding on the collateral constraint and can freely accommodate the bank debt. The higher γ_b, the more costly is to change the bank debt position. I show in figure 45 the dynamics of a big firm, $\bar{k} = 35$, after imposing the same shocks as in section 2.5, but with $\gamma_b = \frac{1}{10}$ (red dotted line) and $\gamma_b = \frac{1}{100}$ (blue line). The higher γ_b, the more costly is increasing bank leverage, and the big firm end up decreasing more dividends.

Robustness with parameter κ:

Both benchmark and counterfactual exercises of section 2.5 have been done under the assumption that

	(1) 20	(2) 25	(3) 29	(4) 32	(5) 40
Non durable good					
ϵ_t	99.96	94.19	53.02	75.39	92.89
ϵ_t^b	0.04	5.81	46.98	24.61	7.11
Investment					
ϵ_t	90.47	14.55	78.89	91.69	98.11
ϵ_t^b	9.53	85.45	21.11	8.31	1.89
Interest rate trade debt					
ϵ_t	87.67	73.56	9.45	7.37	7.12
ϵ_t^b	12.33	26.44	90.55	92.63	92.88
Bank debt					
ϵ_t	0.00	0.00	72.68	87.98	96.97
ϵ_t^b	100.00	100	27.32	12.02	3.03
Trade debt					
ϵ_t	99.55	94.19	53.02	75.39	92.89
ϵ_t^b	0.45	5.81	46.98	24.61	7.11
Dividends					
ϵ_t	75.70	78.2	77.3	91.43	98.07
ϵ_t^b	24.30	21.8	22.7	8.57	1.93
Total leverage					
ϵ_t	1.68	2.5	48.80	67.12	89.52
ϵ_t^b	98.32	97.5	57.20	32.88	10.48

Table 27: Variance decomposition

κ=0'5. That implies that the supplier and the manufacturing firm have the same bargaining power. Now I show how do the model react to changes in this parameter, for κ=0'1 and κ=0'9. For both small and big firms, the bigger is the bargaining power of the supplier, the higher is the increase in trade debt interest rate. On the other hand, if the bargaining power of the supplier is very small, then the trade debt interest rate almost do not change during crisis. In figure 46 I display the results for a firm with steady state size $\bar{k} = 28$, a medium size firm that is binding on its collateral constraint in steady state. For small and medium firms, the difference between having low bargaining power (red dotted line) and high bargaining power (blue line) is considerable. Low bargaining power implies a huge increase in trade debt interest rate, which is translated to a intense decrease in non durable demand and dividends. On the other hand, a high bargaining power for the manufacturing firm helps it to get an almost constant trade debt rate, and consequently the decrease in non durable demand and in dividends is much lower. In figure 47 I show the results for a big firm, a firm with steady state size $\bar{k} = 35$. Notice that there is almost no difference between having low or high bargaining power, since the big firm has access already to additional bank debt.

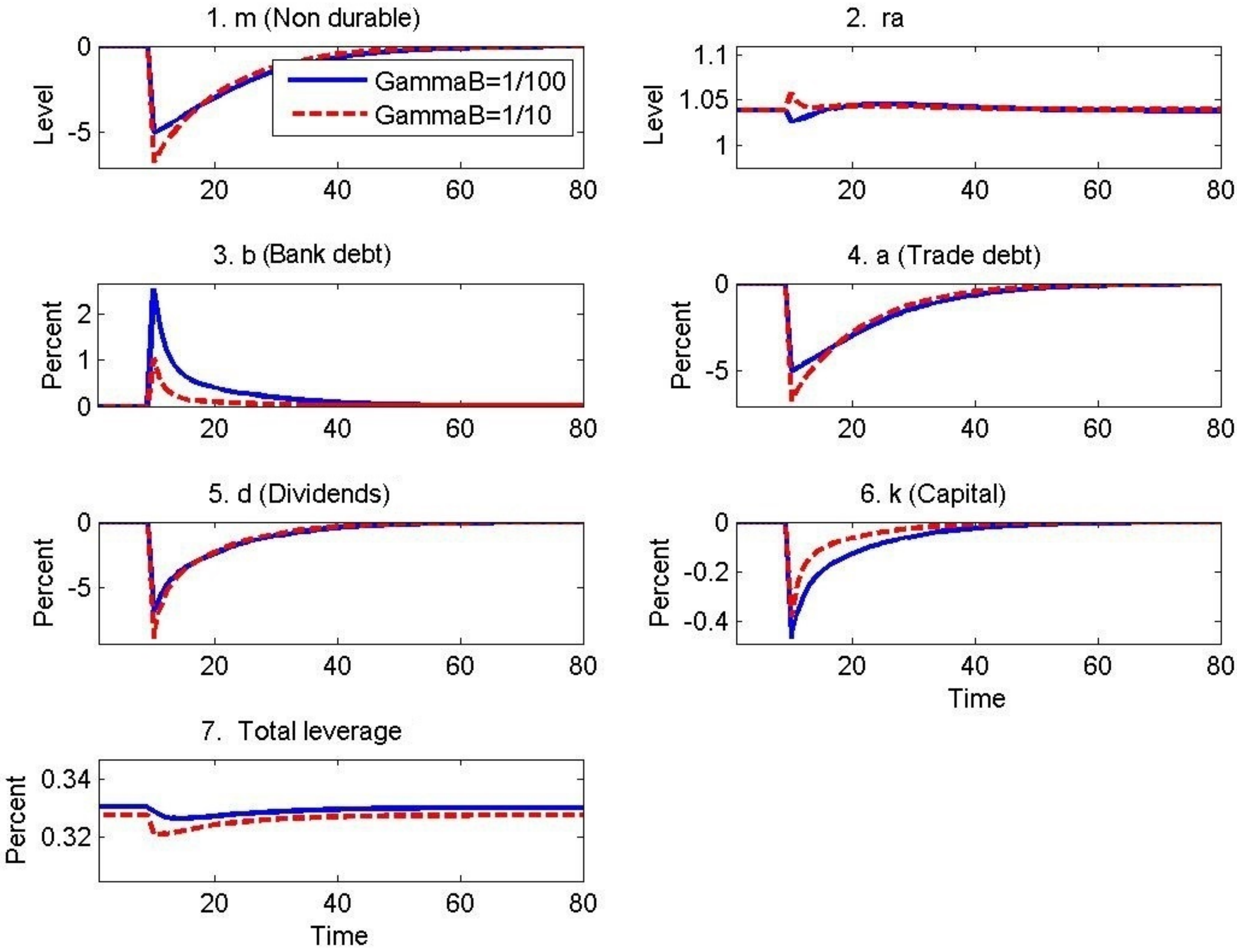


Figure 45: Impulse response functions for big firms. Robustness γ_b

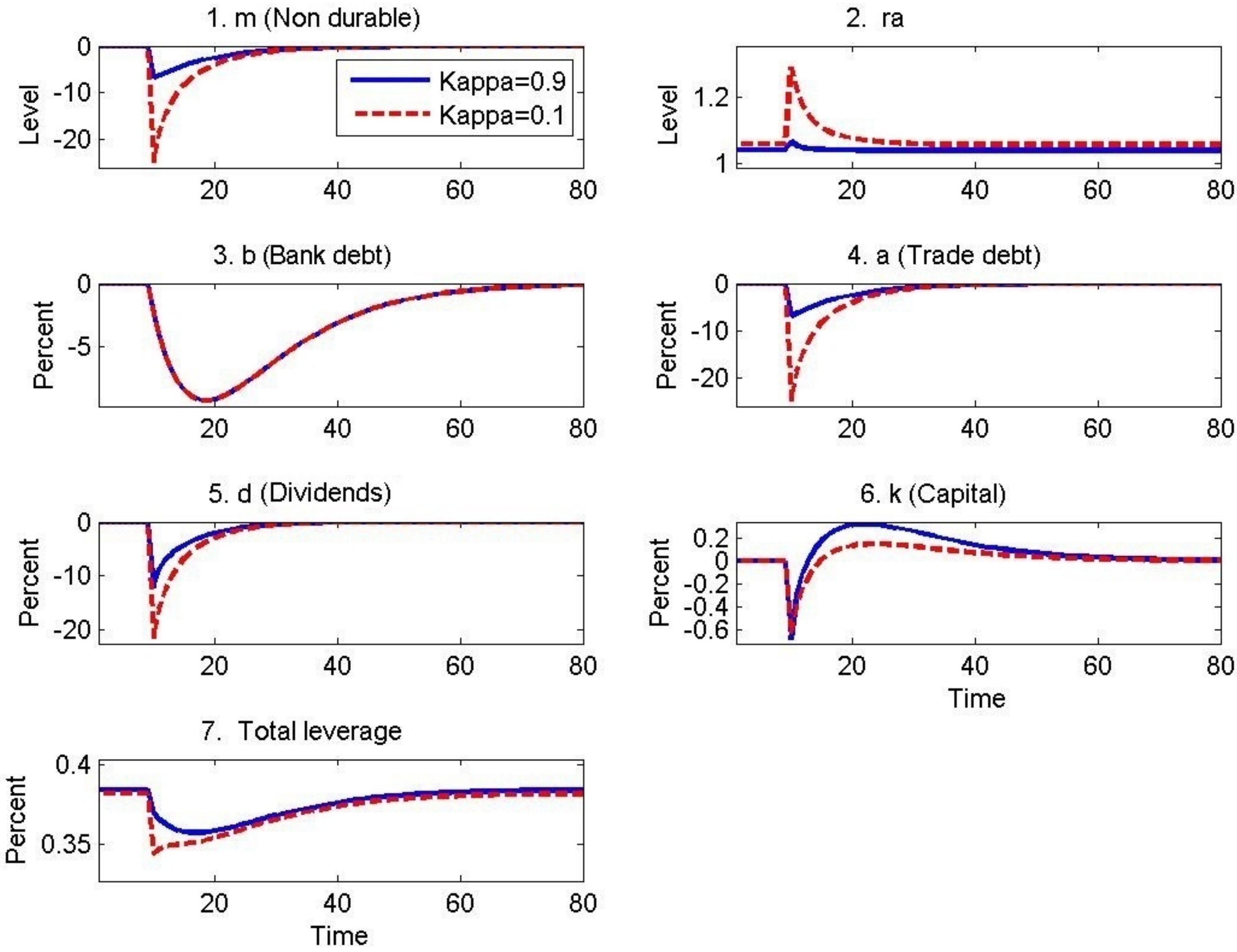


Figure 46: Impulse response functions for medium firms. Robustness bargaining power

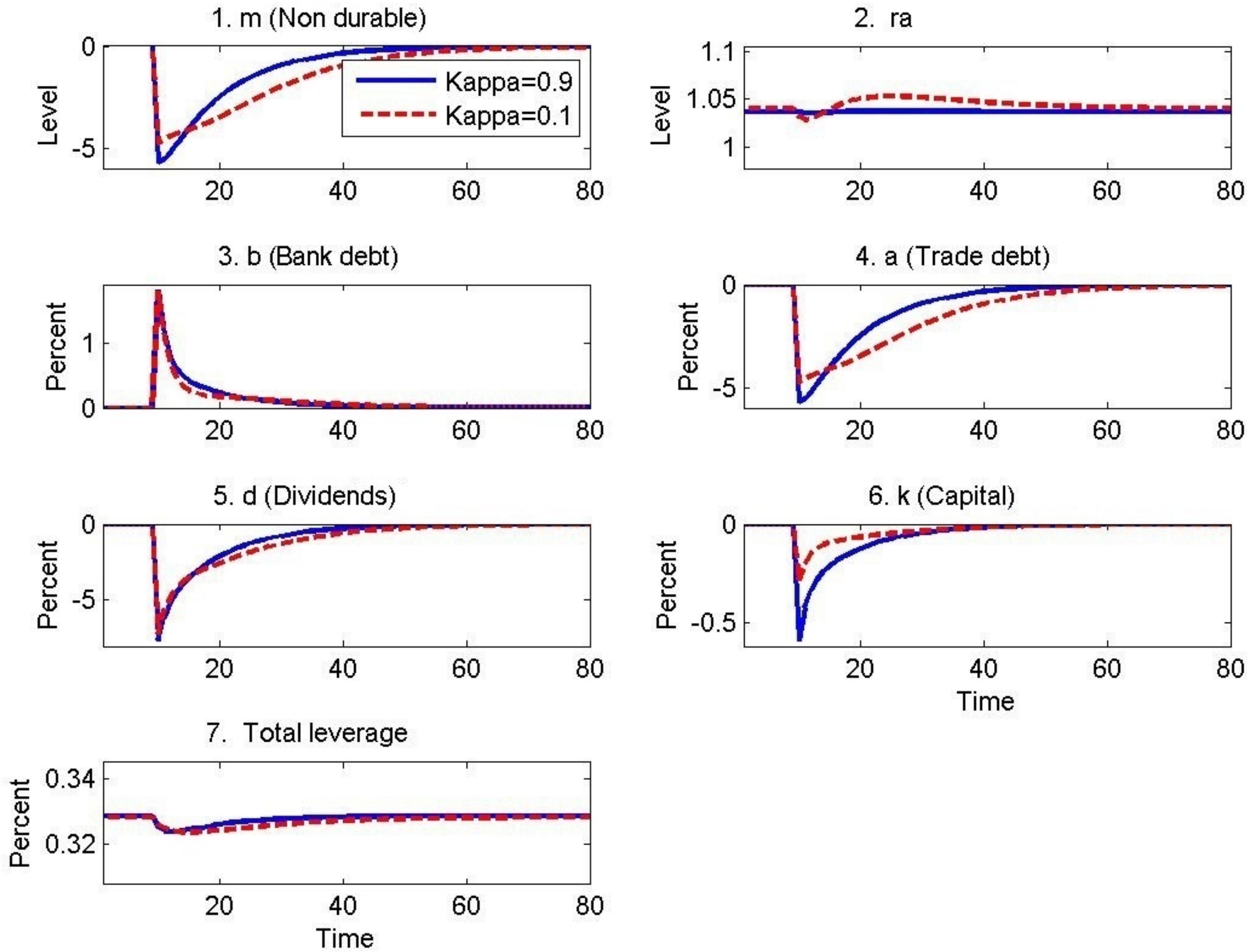


Figure 47: Impulse response functions for big firms. Robustness bargaining power

3 Aggregate implications of governments' delayed payments

3.1 Introduction

One of the main features of the 2008 crisis is the increased importance of access to credit. This is a problem concerning not only firms but also governments, specially when the unemployment rise and fall of economic activity have led to a significant decrease of tax revenues and to an increase of fiscal deficits. Some European governments facing fiscal problems increased bond issuance considerably. From 2007 to 2015, debt over GDP increased from 35% to 99.2% in Spain, from 99.8% to 131% in Italy, from 68.4% to 129% in Portugal and from 103% to 179% in Greece. These huge increases of public debt have coincided with increases in sovereign risk premium and downgrades on debt qualification. Sovereign spread reached its peak in 2011, when Spanish and Italian sovereign spreads rose up to 5%, Portuguese's premium up to 15% and Greece's premium up to 30%. While bond issuance and sovereign premiums were increasing, a new kind of fiscal instrument gained relevance: delayed payments to suppliers. A part of public services and goods are provided through private suppliers. If a government can delay payments to its supplier, then it can have access to an additional way of funding public expenses. As I show in the empirical section of this paper, countries with high debt issuance and sovereign spread risk above European average are the ones that delayed more payments to their private suppliers. In 2011 Spanish, Italian, Portuguese and Greek public late payments were three times larger than the EU average. In addition, these public delayed payments in Spain and Greece accounted up to 8% of GDP, Portugal up to 11%, while average of the European Union was around 5%. Therefore, delayed payments appear to be an additional way of equilibrating public finances, and have a considerable size. What are the aggregate implications of governments' delayed payments? Answering that question is the purpose of this paper.

In order to address the proposed research question I build a novel DSGE model. It consists on a closed economy populated with a representative household, a representative firm, an external bank and a government. The government must finance an exogenous amount of final good each period using three fiscal instruments: labor income taxes, sovereign debt and delayed payments to the firm. The use of taxes and sovereign debt is constrained by institutional limits and fiscal limits. If public expenses exceed the maximum level available of taxes and bonds, the government must delay payments to the representative firm. This firm, which I also refer to as the public supplier, is a representative final good producer. It rents labor from households, distributes profits between dividends and savings, and it faces two financial constraints: a costly equity issuance and a working capital constraint. The working capital constraint specifies that labor should be paid to the household before production takes place. In order to pay in advance, the firm can use an intratemporal loan from the bank by pledging its end of period resources. But government delayed payments could affect the end of period resources, and thus the optimal choice of labor and savings by the firm. Consequently, there exists a trade-off when the government uses delayed payments. On the one hand, if the government can delay payments to its supplier, then it has access to an additional way of funding public expenses and equilibrating its budget constraint. On the other hand, delaying payments to the supplier could have a negative effect on supplier's production and employment decisions. If the supplier has accumulated enough wealth through savings, then its future labor and savings decisions are less likely to be affected by the interaction of the working capital constraint and the government delayed payments.

I solve the model using value function iteration with four states, taking into account an occasional binding constraint (the working capital constraint). Calibration is done in line with the Spanish economy during the 2008-2012 crisis. Once the model is calibrated, I show under which conditions are public delayed payments distortionary. I compare my benchmark model with a model in which government can issue an unlimited amount of debt (no fiscal limit model). Fixing government consumption around 20% of GDP, delayed payments around 8% over GDP, and public debt around 90% (as in Spain in 2011), I show that if the economy is in a low wealth state (firms' debt over assets is 70%) consumption is 5% less in the benchmark model, labor is 10% less and savings are 20% less. These effects are amplified as public debt and new delayed payments increase. If the economy is in a higher wealth state, i.e. firms' debt represents 60% or less over assets, then consumption is not lower in the benchmark model in comparison with the no fiscal limit model. Labor and savings are lower, but not as in the low wealth state. Consequently, for a given level of state variables, the more delayed payments, the greater are the distortions in consumption, labor and savings. In addition, for a given value of new delayed payments, the lower the wealth, the greater is the distortion.

If the public supplier is wealthy (or if it has access to additional funding), using delayed payments as a fiscal tool can increase consumption with respect other fiscal policies in the short run. However, even when the supplier is wealthy, the use of delayed payments reduces firm's savings. Therefore, in the long run, the use of public late payments cause the supplier to be less wealthy, and thus more likely to see its optimal decisions constrained.

In addition, I perform a simulation of the benchmark economy, in which for some periods public consumption follows an explosive regime in line with the Spain's fiscal experience of 2008-2012. I compare the benchmark fiscal policy with alternative scenarios and fiscal tools. I show that using corporate dividend taxes or additional sovereign debt instead of delayed payments can increase consumption, labor and savings during the explosive public consumption regime.

This paper is related to three kinds of literature. First of all, it is linked to the literature on trade debt. Government delayed payments can be considered trade debt, since both trade debt and delayed payments are accounts payable outstanding. Literature on trade debt is mostly empirical. There have been two attempts to evaluate empirically the effect of government delayed payments. Delgado et al. (2015) and Checherita-Westphal et al (2016) use VAR approaches to assess the effect of government delayed payments in the economy. But these two papers do not provide a theoretical model, and thus cannot perform counterfactual analysis. There have been some attempts to create a theory of trade debt. There are two recent papers that do acknowledge the aggregate importance of trade debt in the economy. Shao (2016) uses a DSGE models with two types of debt, and tests which are the implications of trade credit drop in the economy. Altinoglu (2016) proposes a network economy in which all firms borrow trade credit from their supplier and lend trade credit to their clients. However none of these papers have modeled trade debt between government and firms, and thus cannot evaluate the government delayed payments as fiscal policy. To the best of my knowledge, my paper is the first attempt to create a theory of government delayed payments and account for its consequences.
Secondly, my paper is associated to the literature of fiscal policy and fiscal limits. The literature of fiscal policy has not considered yet the use of government delayed payments as a fiscal tool. The fiscal limit that I present is similar to the one proposed by Bi and Leeper (2010) and Bi (2012). In their models, sovereign borrowing is subject to a fiscal limit. This limit is computed as the expected discounted sum of public surpluses. When borrowing exceeds the fiscal limit, the probability of default rises. But they do not study the possibility of using delayed payments as a tool of fiscal policy to alleviate the fiscal limit. A related paper to the concept of public late payments is D'Erasmo and Mendoza (2016), who considers the possibility of domestic default. A public late payment is similar to a domestic default, since it is also also affecting domestic individuals. But a late payment is not technically a default. In the appendix I propose an extension which includes a semi open economy set up and the probability of

default, so my paper is also related to the literature of sovereign default. Part of the literature models default as an optimal choice of the government, as the seminal papers of Eaton and Gersovitz (1981) and Arellano (2008). In my model, the government does not decide to default, and default happens whenever debt is above a certain threshold.

Lastly, the paper is related to the literature that studies financial frictions. The financial constraints of the model, the collateral constraint and the costly equity issuance, are similar to the one proposed by Monacelli (2011), buy they cannot model the relationship between the collateral constraints, the costly equity issuance and the government delayed payments.

The rest of the paper is organized as follows: Section 3.2 presents the empirical data. In this section I define what government delayed payments are, I present data about the evolution of government delayed payments in Europe, and finally I test the relationship between sovereign debt, sovereign spreads and delayed payments. Section 3.3 contains the benchmark model, section 3.4 the calibration, section 3.5 the results and section 3.6 contains the conclusion. The appendix, section 3.7, includes definitions of the variables and an extension of the model with a quasi-open economy.

3.2 Empirical data

In this section, firstly I provide the definition of a public delayed payment. Secondly, I describe the evolution of public delayed payments in Europe from 2007 to 2014. Lastly, I propose a regression to understand the determinants of governments' late payments.

3.2.1 Definition of government delayed payments and empirical facts

A delayed payment is similar trade credit, i.e. money owed by an entity to another entity for goods and services that they have supplied. Delayed payments can take place between businesses, between businesses and their clients, or between public authorities and businesses. This paper focuses is on delayed payments from public authorities to private businesses.

First of all, it is essential to distinguish between payment term and payment delay. According to the European Commission, the payment term is "the time period set out in the contract, and agreed by the

two parties. It is thus the period allowed for a buyer to pay off the amount due". On the other hand, the payment delay is "the period starting after the due date according to the contract (payment term), until the payment is received". In Europe there is a considerable heterogeneity on the payment terms and payment delayed days across countries. Table 28 shows the average terms and delays for different European countries for the period 2007-2014. This data is obtained from Instrum Justitia, a company that conducts surveys across Europe since 2004 about term and delays days. In table 28, it is evident that terms days are more than double in Spain and Italy, 82 and 84 days respectively, than the average of the European Union, 37 days. The number of term days in Portugal and Greece, 60 and 71 days respectively, almost doubles the European Union average.
But not only term days are higher in the aforementioned countries, there is also a sizeable difference in delayed days with respect the rest of European Union countries. Delayed days in Italy, Portugal and Greece, 72, 79 and 90 respectively, are almost three times higher than the EU average, 24 days. In Spain, days of delay are more than twice the average of EU, 55 days. In order to know the total duration of the late payment, term and delay days must be summed up. That means that the total duration of the late payment from public authorities to businesses in Greece for example takes 71 days plus 90 days on average, 161 days. On average, firms dealing with the public system in Greece have to wait almost half a year to get paid.

The differences in payment terms days and delayed payment days have evolved since the beginning of the 2008 crisis. In figure 48, I show the evolution of public delayed days for Spain (pink), Italy (red), Portugal (black), Greece (green) and the average of the European Union (yellow). While this average has barely changed in the European Union from 2007 onwards, in Spain it grew from 40 days to 90 days, in Greece it grew from 60 days to 120 days, and in Italy from 40 to 80 days. Average late payments in Portugal did not change much from 2007 to 2014, but have been very high, around 80 days. To recap, some European countries have higher number of days of terms and delays than the rest of EU countries. These differences increased from 2007 to 2014. But how big are these delayed payments in terms of GDP? It is complex to assess the exact quantity since each country has a different accounting system. A good proxy for the exact amount of government delayed payments is the outstanding public accounts payable that Eurostat reports. In figure 49, I show outstanding public accounts payable over GDP for Spain (pink), Italy (red), Portugal (black), Greece (green) and the average of the European Union (yellow) countries. Average outstanding public accounts payable over GDP in European Union grew at a steady pace from 5% in 2008 to 7% in 2014. During those years, Spain, Portugal and Greece experienced significant increases on their public accounts payable. In Spain they increased from 6% in 2008 to 8% in 2011, Greece from 8% in 2008 to 11% in 2012 and Portugal from 5% in 2008 to 11% in 2011. In Italy, public accounts payable stayed constant around 5%. Figure 49 suggests that government late payments represent a considerable part of GDP in countries with high payment terms and high payment delay days.

Country	Term days	Delay days
Spain	82.69	55.39
Italy	84.90	72.31
Portugal	60.69	79.95
Greece	71.42	90.42
Germany	24.97	12.36
United Kingdom	28.50	17.47
France	46.79	19.55
Average EU	37.32	24.37

Table 28: Average term and delay days, 2004-2014

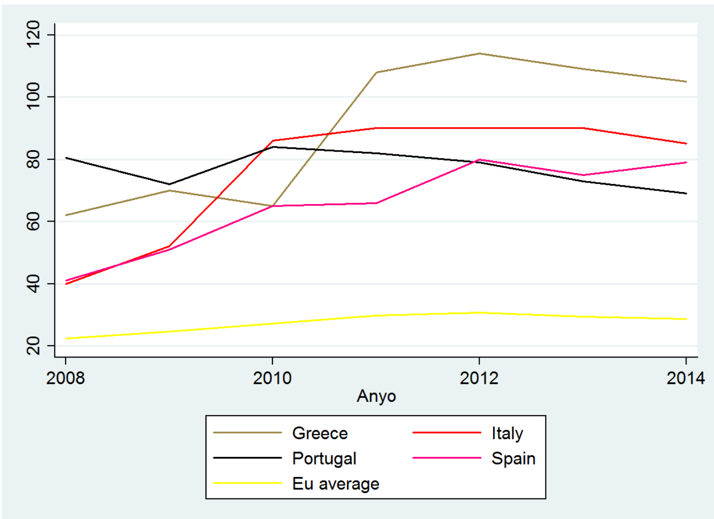


Figure 48: Evolution of delayed payment days, 2008-2014

This phenomenon was noticed by European authorities. The European Union issued the European Directive 2011/07/EU on combating late payments in commercial transactions. This directive was issued because late payments between businesses, and between public authorities and businesses were getting worse. It is a remedy for late payments. The directive stated that public authorities have to pay for the goods and services that they procure in 30 days, and in very exceptional circumstances, they are allowed to settle in 60 days. The directive has been applied from 16 of March of 2013 onwards.

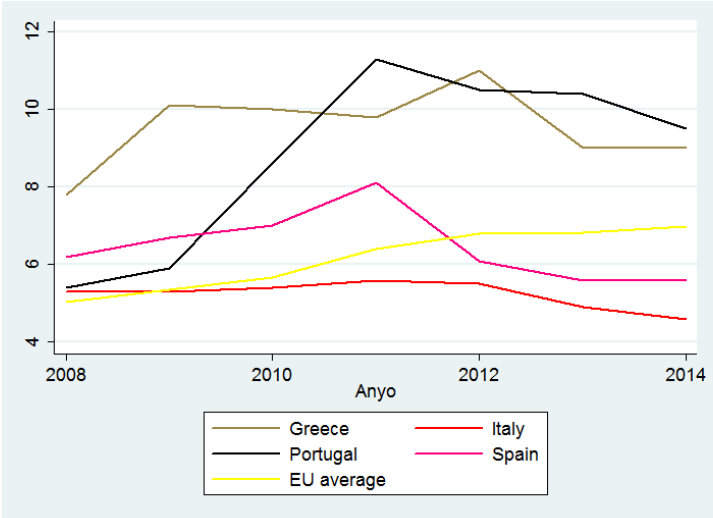


Figure 49: Evolution of outstanding accounts payable over GDP, 2008-2014

Interest rate for late payment was set at a statuary rate of at least 8% above the European Central Bank's reference. While a slight improvement can be appreciated in figure 48 and 49 in terms and delay days, Spain, Portugal, Italy and Greece are still far away from the target set by the European Union.

3.2.2 Determinants of governments' delayed payments

There is a noticeable heterogeneity regarding the amount of public late payments in Europe. Why Italy, Spain, Portugal and Greece are delaying their public payments by so many days? I show that the main determinant of having high government delayed days is the interaction of high public debt with high sovereign spreads. In figure 50 are displayed the data points corresponding to the days of delay (vertical axis) and sovereign spread (horizontal axis) for 26 European countries for the years 2007-2014[15]. I also display the OLS line that fits these points. It can be seen that there is an apparent positive correlation between both variables. The more sovereign spread, the more days the public payments are delayed. Figure 51 displays the correlation between days of delay (vertical axis) and sovereign debt (horizontal axis). Again, an evident positive correlation can be appreciated between both variables. The more sovereign spread, the more days of delay in the public payments.

In addition, I want to assess how important is the interaction of high sovereign debt and high spreads on

[15]Countries considered are: Austria, Belgium, Germany, Spain, Finland, France, Ireland, Italy, Netherlands, Portugal, Denmark, Sweden, United Kingdom, Czech Republic, Hungary, Poland, Estonia, Lithuania, Latvia, Switzerland, Iceland, Norway, Greece, Cyprus, Slovakia, Slovenia.

days of delay of public payments. I propose the following least squares dummy variable model (LSDV):

$$\text{Days of delay}_{i,t} = \beta_0 + \beta_1(\Delta GDP_{i,t} - \overline{\Delta GDP}) + \beta_2(TermDays_{i,t} - \overline{TermDays})$$
$$+ \beta_3(SovereignDebt_{i,t} - \overline{SovereignDebt}) + \beta_4(SovereignSpread_{i,t} - \overline{SovereignSpread})$$
$$+ \beta_5(SovereignDebt_{i,t} - \overline{SovereignDebt}) * (SovereignSpread_{i,t} - \overline{SovereignSpread})$$
$$+ \beta_6 Dummytime + \beta_7 Dummycountry + \varepsilon_{i,t} \qquad \textbf{(3)}$$

where $\Delta GDP_{i,t}$ is growth of GDP and $\varepsilon_{i,t}$ is a standard error. Dummytime and Dummycountry are dummy variables to take into account the different countries and different years. I subtract to all the regressors their mean. This way it is clearer the interpretation of the coefficient of interest, β_5. The interpretation of the regressors is how do the days of delay change when the level of the regressors is different from the mean. I present the results from the LSDV estimation in table 29. Table 29 shows that the interaction of debt and sovereign spread is significant at 1% and positive. This means that if the sovereign debt of a country and its sovereign spread are above the average in EU, then increases in either sovereign spread or sovereign bonds have a positive effect on days of delay. In the next section I propose a benchmark model that is able to replicate the fact that, the higher the sovereign debt, the more likely a government is to delay payments to its suppliers. In the appendix I include an extension with sovereign spreads, in which the higher the sovereign debt and sovereign spreads, the bigger the public late payment.

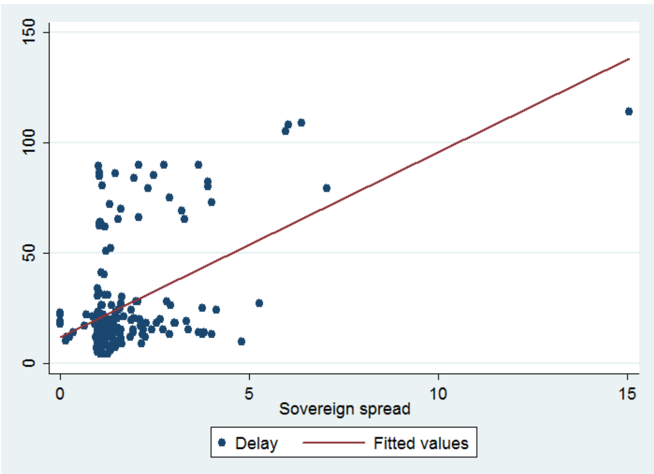


Figure 50: Correlation government delay days and sovereign spread, EU countries, 2005-2014

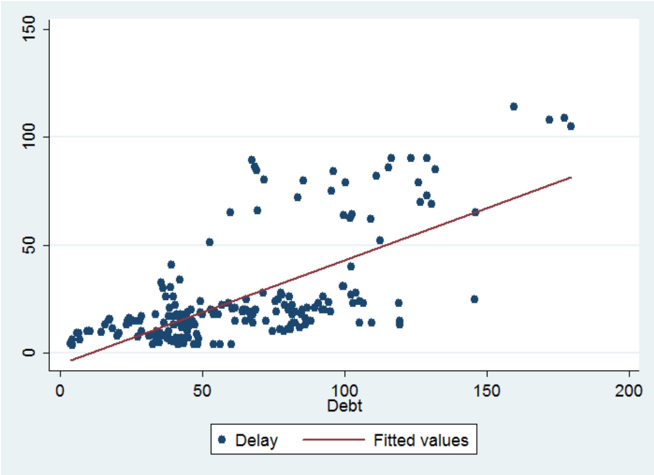


Figure 51: Correlation government delay days and sovereign debt

	(1)
	Days of delay
Term	-0.213*
	(0.1217)
ΔGDP	-0.225
	(0.2528)
Debt	0.0533
	(0.04801)
Sovereign spread	-0.576
	(0.8727)
Debt*SovereignSpread	0.0346***
	(0.0104)
Constant	29.80***
	(6.4086)
Standard errors in parentheses	
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$	
Observations	200
Year fixed effects	YES
Country fixed effects	YES
Method	LSDV

Table 29: LSDV regression

3.3 Benchmark model

This model is based in a closed economy, populated with a representative household, a final good producer firm, an external bank and a government. I consider an infinite horizon set up.

3.3.1 Household

The representative household consumes c_t amounts of final good and rents labor l_t to the final good producer firm. The household is the owner of the firm, so every period she can buy shares of the firm s_{t+1} at a price q_t^f. She is able to sell her shares s_t. If the household sell her shares, she gets the price of the share and the dividends d_t of the firm at the end of the period. The household is subject to a labor income tax τ_t imposed by the government. At the end of the period she receives only a fraction $(1-\tau_t)$ of her total labor income. The household has also access to the sovereign bond market. She can lend to the government using government bonds b_{t+1}, sold at price q_t. The complete value function problem of the household has two endogenous state variables: sovereign bonds b_t and shares of firm s_t. The household problem can be written as follows:

$$V^h(s_t, b_t) = \max_{c_t, l_t, s_{t+1}, b_{t+1}} \left\{ u(c_t, l_t) + \beta \mathbb{E}_t[V^h(s_{t+1}, b_{t+1})] \right\}$$

$$\text{st } c_t + q_t^f s_{t+1} + q_t b_{t+1} \leq (1-\tau_t) w_t l_t + (q_t^f + d_t) s_t + b_t$$

where w_t is the wage paid by the firm and $\beta \in (0,1)$ is the discount factor. The utility function is such that consumer enjoys consumption of final good and leisure, and it takes the following form: $u(c_t, l_t) = log(c_t) + (1-\gamma) log(1-l_t)$.

3.3.2 Government

At every period t, the government must finance public consumption G_t, which is an exogenous, unproductive amount of final good. The government buys this final good from the final good producers. I suppose that the government consumption follows a Markov process with two values, $\underline{G}$ and $\overline{G}$. In the calibration section I specify the probability matrix for this Markov process. The government can finance G_t trough three fiscal instruments: labor income taxes, sovereign bonds and delayed payments to the final good producer. Labor income taxes consist on a fraction τ_t of total labor income of the household. Sovereign bonds b_{t+1} are one year bonds sold to the household at price q_t. I assume that government cannot default on its obligations, although in the appendix I include a version with partial sovereign default. Last, delayed payments Δ_{t+1} are delayed payments to the final good producer. Since the government buys final good from the producer, a way to finance itself in t is delaying a part of the payment of the final good bill in t and pay for it in $t+1$. In $t+1$ the government will be able to delay further payments, so delayed payments can be rolled over.

In every period, the expenses of the government are defined by the sum of the government's consumption G_t, plus past debt b_t and past delayed payments Δ_t. In order to pay for these expenses, the government uses a combination of the three fiscal instruments according to the following fiscal rule: First of all, the government tries to cover all the expenses with labor income taxes. However, I do not allow taxes to be above a given value T, meaning that $\tau_t \in$[0,T]. This can be thought as an institutional constraint. It is reasonable to think that labor taxes have an upper bound, since too high labor taxes can be inefficient from collection point of view (Feldestein 1995) [16]. If the expenses of the government are bigger than $Tw_t l_t$, then the government tries to issue new debt, b_{t+1}. The constraint of the government up to now is as follows:

$$
\begin{aligned}
G_t + b_t + \Delta_t &= \tau_t w_t l_t && \text{if } G_t + b_t + \Delta_t \leq T w_t l_t \\
G_t + b_t + \Delta_t &= T w_t l_t + q_t b_{t+1} && \text{if } G_t + b_t + \Delta_t > T w_t l_t
\end{aligned}
$$

In addition, I consider that sovereign bonds are subject to a limit, a fiscal limit like in Bi and Leeper (2010) and Bi (2012). This limit B_t^{limit} is computed every period as the expected discounted sum of fiscal surpluses. It measures government capacity to service its debt:

$$B_t^{limit} = \mathbb{E}_t \sum_{i=0}^{\infty} \beta^i \left\{ \tau_{t+i} w_{t+i} l_{t+i} - G_{t+i} \right\}$$

The government computes this fiscal limit each period, and it commits to not issue a bigger amount of bonds than the amount specified by the fiscal limit. If the government hits the fiscal limit, then it needs to use the third and last fiscal tool: delayed payments to its supplier. The complete constraint of the government is as follows:

$$
\begin{aligned}
G_t + b_t + \Delta_t &= \tau_t w_t l_t && \text{if } G_t + b_t + \Delta_t \leq T w_t l_t \\
G_t + b_t + \Delta_t &= T w_t l_t + q_t b_{t+1} && \text{if } T w_t l_t < G_t + b_t + \Delta_t < T w_t l_t + q_t B_t^{limit} \\
G_t + b_t + \Delta_t &= T w_t l_t + q_t B_t^{limit} + \Delta_{t+1} && \text{if } G_t + b_t + \Delta_t > T w_t l_t + q_t B_t^{limit}
\end{aligned}
$$

To recap, the government needs to cover its expenses each period and it uses the following fiscal rule: First of all, it tries to cover the public expenses with labor income taxes. If taxes are above the institu-

[16] Labor income taxes are never bigger than 50%.

tional limit, then the government issues new debt. And if this new debt is above the fiscal limit, then the government needs to delay payments to the final good producer.

3.3.3 Final good producer

During the paper I also refer to the final good producer as the government's supplier or the representative firm. It rents labor l_t from household in order to produce final good y_t through the following technology: $y_t = F(k, l_t) = k^{\alpha} l_t^{1-\alpha}$. Notice that capital k is fixed and is owned by the firm. At period t the firm can distribute dividends d_t or accumulate savings a_{t+1}. I assume that the firm has access to a technology that allows final goods to be stored. In period t, it can save a unit of final good a_{t+1} and get $(1+r)a_{t+1}$ in period $t+1$. This way the firm can accumulate wealth. Final good is consumed by both the household and the government. The timing for the model is as follows: At the beginning of the period, the government demands G_t and announces if it will delay payments or not to the firm. The government can do this since it knows if the institutional and fiscal limits are constraining its budget. Therefore the firm knows both G_t and Δ_{t+1} (the public demand for final good and which fraction of it will not be paid today) when it takes its decisions. I assume that the firm is required to pay inputs before production takes place, i.e. there is a working capital constraint. In order to pay in advance, it can use an intratemporal loan from the bank by pledging its end of period resources. Consequently, the amount of labor that the firm can rent depends on its amount of end of period resources. These resources are composed by the accumulated wealth of the firm, firm's sales, and the amount of past and present delayed payments owed by the government. At the end of the period, the firm repays the intratemporal loan and decides how to allocate the end of period resources among dividends or savings. The value function problem of the firm is as follows:

$$V(a_t, G_t, \Delta_t) = \max_{d_t, l_t, a_{t+1}} \{d_t + \mathbb{E}_t \beta_{t,t+1} V(a_{t+1}, G_{t+1}, \Delta_{t+1})\}$$
$$d_t \leq F(k, l_t) - \Delta_{t+1} - w_t l_t - a_{t+1} + a_t(1+r) - \Gamma_t + \Delta_t$$

$$\Gamma_t = \gamma_d (d_t - \overline{d})^2$$

$$w_t l_t \leq \eta (F(k, l_t) - \Delta_{t+1} + a_t(1+r)) + \eta^{\Delta} \Delta_t$$

$$\Delta_{t+1} = \theta_t F(k, l_t), \text{ where } \theta_t \in [0, 1)$$

$F(k, l_t) = k^{\alpha} l_t^{1-\alpha}$

where Γ_t is a costly equity issuance as in Jermann and Quadrini (2012), η is the collateral value of the end of period resources, and $\beta_{t,t+1}$ is the stochastic discount factor reflecting the fact that the firm is owned by the household. I consider that the external bank collateralizes differently the government's past delayed payments by η^{Δ}. I assume that the bank cannot get track of the delayed payments that the government owns to the firms, Δ_t, and thus it has pay a cost in order to reveal it. This cost is translated into a smaller collateral value of the past delayed payments.
Notice that the delayed payments must be a fraction θ_t of total production, since the government cannot delay more payments than the total amount of final good available in the economy. Now that I have described the economy, I can present the intuition about the use of delayed payments. There is a trade-off. On the one hand, by delaying payments to its supplier, the government can access an additional way of funding public expenses and equilibrating its budget constraint. On the other hand, delaying payments to the supplier could have a negative effect on the production and employment decisions of the supplier. The role of the financial constraints is crucial in determining the aggregate effect of government's delayed payments. I present three propositions that help to understand that aggregate effect.

Proposition 1: Without financial frictions, public delayed payment are a lump sum tax.

There are two financial frictions in this economy. The working capital constraint and the costly equity issuance. To illustrate best this proposition I show the first order conditions of the firm. First order condition with respect to labor is:

$w_t(\lambda_t + \psi_t) = F^l(k, l_t)(\lambda_t + \eta\psi_t)$ (1)

where λ_t is the multiplier of the resource constraint of the firm, and ψ_t is the multiplier of the working capital constraint. Term $F^l(k, l_t)$ represents the marginal productivity of labor. The first order condition with respect accumulating wealth a_{t+1} is:

$\lambda_t = (1 + r)\mathbb{E}_t\beta_{t,t+1}(\lambda_{t+1} + \eta\psi_{t+1})$ (2)

and the first order condition with respect to dividends is:

$1 = \lambda_t(1 + 2\gamma_d(d_t - \bar{d}))$ (3)

Without the working capital constraint, the multiplier of that restriction, ψ_t, will not be present in equations (1) and (2). Then, from equation (1) we get $w_t = F^l(k, l_t)$, marginal cost of labor is equal to marginal productivity of labor, so delayed payments will never distort the optimal labor decision. Without the costly equity issuance, $\gamma_d = 0\ \forall t$, and from (3) I get that $1 = \lambda_t\ \forall t$, meaning that the value of distributing dividends never change regardless the size of the government late payment. And from (2) I get $1 = (1+\text{r})\mathbb{E}_t\beta_{t,t+1}$, so depending on the value of the interest rate with respect the stochastic discount factor, the firm will accumulate savings or not. If $1>(1+\text{r})\mathbb{E}_t\beta_{t,t+1}$, then the firm only issues dividends and does not save, and if $1<(1+\text{r})\mathbb{E}_t\beta_{t,t+1}$ the firm does not distribute dividends and firm devotes all the resources to save. If $1=(1+\text{r})\mathbb{E}_t\beta_{t,t+1}$, then firm is indifferent between distributing dividends and saving. Since the late payments are equivalent to lump taxes, these results hold with independence of the size of the government's late payments. Bigger government's delayed payments will be translated into negative dividends, and this into a lump sump tax for the household. To recap, savings and labor decisions of the firm are not affected by government delayed payments if there are not financial frictions in the economy.

With financial frictions, government's delayed payments affect the optimal decision for labor and the optimal decision between dividends and savings of the firm. Before going into detail about these effects, I present proposition 2 that will be useful afterward.

Proposition 2: The costly equity issuance implies an optimal level of dividends for the firm.

The costly equity issuance implies that there is an optimal dividend issuance for the firm. This can be seen in equations (2) and (3). The optimal dividend issuance depends on γ_d and the bliss point $\bar{d}$. The bigger is $\bar{d}$, the bigger is the optimal dividend. The bigger is γ_d, the smaller is the optimal dividend issuance. Once the costly equity issuance is included, the firm does not accumulate savings until it reach its optimal dividend issuance.

Now that it is clear the dividend policy for the representative firm, I explain how public delayed payments affect the whole economy in presence of financial constraints.

Proposition 3: Regardless of the wealth accumulated by the firm, government's delayed payments will always affect the optimal decision of the representative firm. The direction and size of this effect depends on the working capital constraint.

Consider an economy that has reached the fiscal limit, so the government must delay payments to the supplier. Let's focus on two scenarios: one in which the supplier is not wealthy enough to overcome the working capital constraint, and another one in which the firm is wealthy enough to not be binding on the constraint. First, I analyze the case in which the supplier is not wealthy enough. In that scenario, public late payments affect directly the working capital constraint, so $\psi_t > 0$ and from (1) it can be seen that the labor decision would be distorted. The bigger the late payment, the lower would be labor demand. Also, if $\psi_t > 0$ the shadow value of issuing dividends might change over time. The decision between dividends and savings is affected. If the firm has reached the optimal dividend policy, then the public delayed payments would imply less savings. If the firm has not reached the optimal dividend policy, then the public delayed payments would imply less dividends.

Secondly, I analyze the case in which the supplier is wealthy enough to overcome the working capital constraint. In that case, late payments does not affect directly the working capital constraint, so $\psi_t = 0$. As before, if the firm has reached the optimal dividend policy, then delayed payments would reduce savings. If the firm has not reached the optimal dividend policy point, then it will reduce dividends directly.

The conclusion from this proposition is that, independently of the wealth of the firm, in presence of financial frictions the government's delayed payment will always affect the dividend/savings decisions of the firm. If the firm is not wealthy enough, it would also affect its labor decision.

Equilibrium:

An equilibrium in t consists of prices w_t, q_t, q_t^f, value functions for household and firms, budget constraint of government, policy functions for household $c_t(s_t, b_t), l_t(s_t, b_t), b_{t+1}(s_t, b_t), s_t(s_t, b_t)$, policy functions firm $d_t(a_t, \Delta_t, G_t), l_t(a_t, \Delta_t, G_t), a_{t+1}(a_t, \Delta_t, G_t)$ and a fiscal policy for the government such that;

i. Policy functions of household solve the household problem

ii. Policy functions for firm solve the firm's problem

iii. Fiscal policy for the government runs a balance budget

iv. Labor market clears $\forall t$

v. Shares of firms clears

3.4 Calibration

Periods in the model are quarters. Most of the parameters follow a standard calibration. I set $\beta = 0.9825$, $\alpha = 0.3$ and $\gamma = 0.28$. Interest rate is set to $r = 0.0178$ so that $\frac{1}{\beta}(1+\text{r}) = 1$. The rest of the parameters are calibrated according to the Spanish economy. I fix the institutional constraint parameter T to 0.4. This way the maximum amount of labor tax revenues over GDP in the benchmark model is 20%. In Spain, tax revenues over GDP were 12% in 2014. I set the values of the Markov chain, $\underline{G}$ and $\overline{G}$ in order to match the figures of public consumption in Spain from 2004 to 2014. During that period, Government final consumption expenditure in Spain oscillated around 15% and 20% over GDP. I calibrate the Markov matrix so delayed payments are on average 6% over GDP in the benchmark model. The resulting Markov matrix is [0.4, 0.6; 0.4, 0.6]. I calibrate the parameter determining the costly equity issuance, γ_d, in line with the average Europeann's dividend payout ratio. In Europe, dividend payout ratio of the top 1000 companies has been oscillating between 40% and 60% from 2002 to 2014. In addition, I consider only those industries that are more likely to act as a government's supplier. The average dividend payout ratio for the industries of defense, construction, education, hospital services and pharmaceutical services is 43%. Consequently, I set $\gamma_d = 1.8$, the one that yields the correct dividend payout ratio in the simulation of the benchmark model. I perform robustness analysis changing γ_d, and the main results of the paper do not change. Last, I calibrate the parameters regarding the collateral value in order to obtain a steady state value of total leverage of 54%. Using the panel data on Spanish manufacturing firms provided by Encuesta Sobre Estrategias Empresariales (ESEE from now on, survey of business strategies) I find that average total leverage ratio for firms above 500 employees in Spain is 54%. Total leverage is a percentage computed as liabilities (amount of obligations/credits of the firm), divided by liabilities and amount of owner's equity. In this model I consider as liabilities the working capital constraint, $w_t l_t$, and as owner's equity the past savings plus payments owed by the government to the firm. The value of the collateral constraint consistent with a steady state value of total leverage of 54% is $\eta = 0.58$. Last, I have to discuss the value of η^{Δ}. For the moment I assume that the collateral value of the payments owned by the government is half of the collateral value of the wealth, so $\eta^{\Delta} = 0.26$. I perform robustness analysis with this parameter. The main results do no change. The higher η^{Δ}, the lower would be the distortion of late payments. Even if $\eta^{\Delta} = 1$, the government's late payments would have a distortion, but it would be independent of the past delayed payment. With $\eta^{\Delta} = 1$, a new late payment would have the same effect independently of how much does the government owe to the firm. Calibration is summarized in table 30.

α	r_a	β	γ_d	γ	η	η^{Δ}
0.3	0.0178	0.9825	1.8	0.28	0.58	0.26
ρ_1	ρ_2	T	$\underline{G}$	$\overline{G}$		
0.4	0.6	0.4	0.45	0.85		

Table 30: Calibration

3.5 Results and policy evaluation

3.5.1 Effects of government delayed payments

In this section I show how do government's delayed payments affect the economy. The effect is shown for given levels of the four state variables: public consumption G_t, past delayed payments Δ_t, public debt b_t and accumulated wealth a_t. The analysis is done for the maximum level of government consumption, $\overline{G}$, equal to 20% of GDP, and for an amount of past delayed payments, Δ_t, equal to 8% of GDP. This way I replicate the situation in Spain in 2011. I show the results for three different levels of accumulated wealth and for a large range of past public debt values. These three different levels of wealth represent three possible states of the economy: a low wealth state, a medium wealth state and a high wealth state. In the low wealth state, the representative firm has 70% of debt and 30% of own funds. In the medium wealth state, the representative firm has 62% of debt and 38% of own funds. And in the high wealth state, the representative firm has 54% of debt and 46% of own funds. In order to test the effect of government's delayed payments, I compare my benchmark model with an alternative scenario; One in which the government is not subject to the fiscal limit, and it can issue bonds indefinitely. This way I can have a notion of how distortionary are public delayed payments. The variables of interest are consumption, labor, wages, savings, and sovereign bond prices. I show these variables for the three different states, and for a wide range of public debt, from 65% of public debt over GDP to 105%. The results are shown from figure 52 to figure 57. The low wealth state is displayed with a red cross dotted line, the medium wealth state is displayed with a blue circle dotted line, and the high wealth state is displayed in black line. On the vertical axis it is shown the ratio of each variable under the benchmark model with respect to the no fiscal limit model. On the horizontal axis it is shown different levels of past public debt.

In figure 56 I show the amount of new delayed payments Δ_{t+1} over GDP in the benchmark model. It can be seen that, before the economy reaches the fiscal limit, new delayed payments are zero. Once the economy reaches the fiscal limit, approximately when past public debt is around 85% of GDP, new delayed payments start growing. New public delayed payments behaves in a different way depending on the level of wealth of the economy. Public delayed payments are higher in the lower wealth state for two reasons: First, because a firm with low savings is more likely to be distorted. As I will explain in the next paragraph, both labor and wages could decrease in the low wealth state as a consequence of the interaction of late payments and financial constraints. This implies less tax revenues, and the necessity for more public delayed payments. Secondly, labor and wages' distortions make the household less willing to lend, and the price of debt decreases. This obliges the government to delay even more payments.

I start analysing the behavior of labor, figure 53. It can be seen that larger amounts of past debt entails lower labor in the benchmark model for all three wealth states. This is because the higher the public debt, the richer the representative household, since she owns the public debt and under the fiscal limit she does not have to pay new taxes or lend more. Because the household is richer, she is less willing to supply labor and therefore labor decreases. This decrease is more intense in the low wealth state, because in that state the representative firm is binding in the working capital constraint. The firm did not accumulate enough savings to overcome the financial constraints. As a result, labor is upper constrained and the representative firm cannot achieve its optimal labor demand. If public debt is 90% over GDP, at the low wealth state labor is approximately 10% lower in the benchmark model. As debt and late payments increase, this difference is higher. In the medium wealth state, the firm also becomes binding once public debt is higher than 95% of GDP. The reduction in labor experienced in the medium wealth state is more severe than the one in the high wealth state.
In figure 54 I present the behavior of wages, which is consistent with the circumstances described for labor. In the high wealth state, since the household is less willing to supply labor, wages increase. This

also happens for the medium wealth state, until the firm becomes binding. If public debt is higher than 95% of GDP, the medium wealth firm becomes binding, and the effect on wages is reversed. Wages decrease severely for the low wealth state, since the firm become binding as soon as the economy reaches the fiscal limit. Labor and wages dynamics help to explain what happens with aggregate consumption, figure 52. In the high wealth state, the more debt, the richer the household in the benchmark model with respect to the no fiscal limit model. Drops in labor are compensated by increases in wages. The same is true for the medium wealth states until the firm becomes binding. After that point, the effect on consumption is reversed. And as expected by the behavior of labor and wages, consumption decrease considerably in the low wealth state in the benchmark model. In the low wealth state, aggregate consumption is 5% less in the benchmark model when public debt is 90% of GDP.
In figure 55 I display the effect on savings. It can be seen that savings are always lower in the benchmark model. The bigger is the delayed payment, the more intense the decrease. This is due to the fact that the delayed payment implies always less resources for the firm. Since the firm is eager to keep the optimal dividend policy, less resources imply less savings. The decrease is more severe for the low and medium wealth state, because the firm in those states is close to be binding. Last, I present the evolution of the sovereign bond price in figure 57. This figure follows a similar structure to the ones of consumption and wages, figures 52 and 54. Under the benchmark model, bond prices decrease considerably for low wealth state as the delayed payments grow. The intuition is that in the low wealth state, since both labor and wages are decreasing as a consequence of the government delayed payments, then the household is less willing to lend to the government. This implies that the bond price goes down, and the government needs to issue more delayed payments. That is one of the reasons why delayed payments are higher for low wealth state than for bigger wealth state.

To recap, for a given level of state variables (public consumption, past delayed payments, public debt and accumulated wealth), the more delayed payments, the bigger is the distortion in consumption, labor and savings. And for a given value of state variables, the lower wealth, the bigger is the distortion in those variables. Notice that if the economy is in the high wealth state, then consumption is higher in the benchmark model than in the no fiscal limit model. So, if the public provider is wealthy and/or has access to additional funding, it can be argued that delaying payments could be a welfare improving fiscal tool. However, even when the supplier is wealthy, delaying payments entail less savings, so in the long run the supplier might get poorer. This process could lead to a different effect of public late payments in the long run.

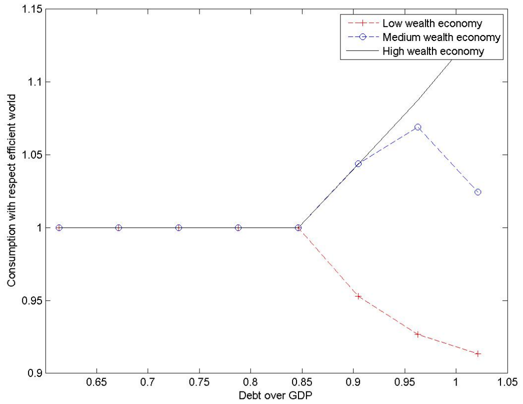


Figure 52: Consumption. Benchmark model vs non fiscal limit model

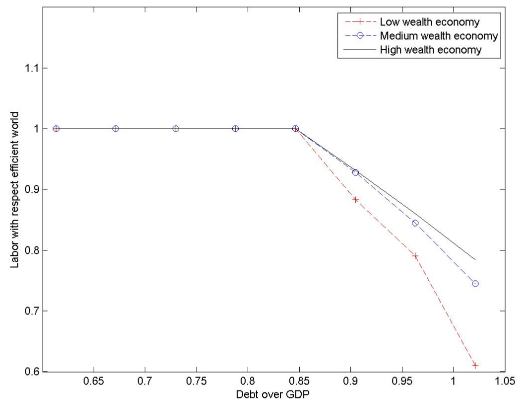


Figure 53: Labor. Benchmark model vs non fiscal limit model

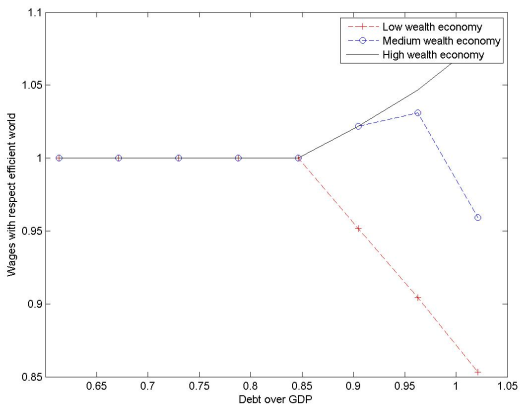


Figure 54: Wages. Benchmark model vs non fiscal limit model

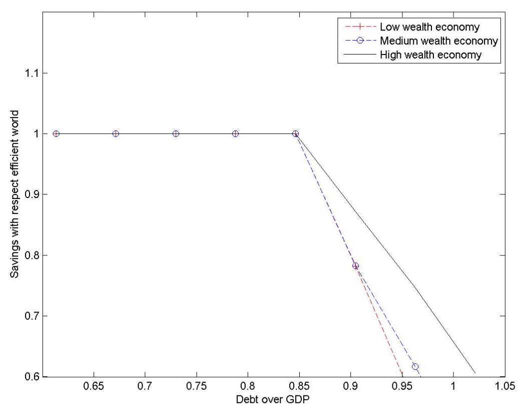


Figure 55: Savings. Benchmark model vs non fiscal limit model

3.5.2 Nonlinear Simulations

I perform a simulation to replicate Spain's fiscal situation during the 2008-2012 crisis. I analyze which has been the role of the government delayed payments under those circumstances, and possible counter-factual scenarios and policies. The economy is simulated for 30 periods. During the first 10 periods, the Markov matrix governing the public consumption changes temporarily to a explosive regime, $\rho_1 = 0.1$ and $\rho_2 = 0.1$. With this I try to capture the increase in public debt during the period 2008-2012. After period 10, the values for the Markov chain are again $\rho_1 = 0.4$ and $\rho_2 = 0.4$. I present the evolution of

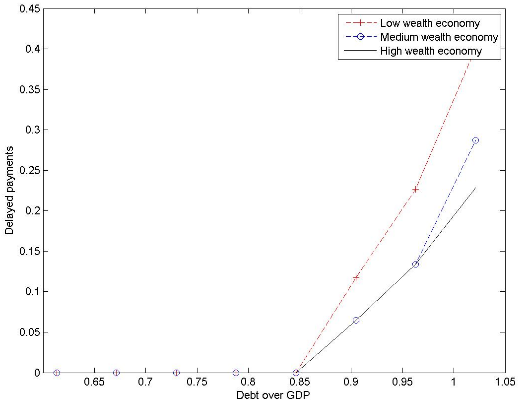


Figure 56: Delayed payments. Benchmark model vs non fiscal limit model

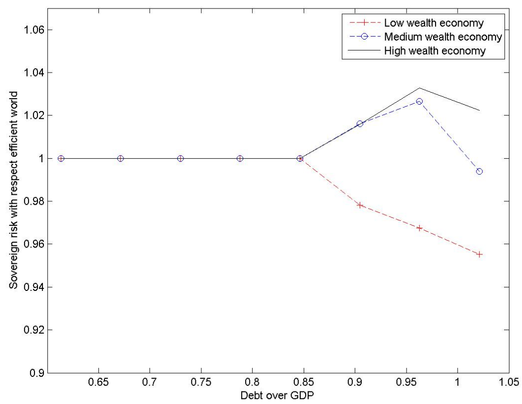


Figure 57: Bond pricing. Benchmark model vs non fiscal limit model

some variables of interest in presence of such a sequence of shocks. The variables of interest are public debt, delayed payments, consumption, savings, labor and wages. All variables are in terms of steady state deviations, except public debt and delayed payments that are expressed in percentage over GDP. Figure 58 and 59 displays the behavior of the benchmark model, while figures 60 and 61 display the behavior of the economy under two alternative fiscal policies.

Figure 58 contains the results of the benchmark model for an economy that starts in a low wealth state, and figure 59 the results of the benchmark model for an economy that start in the highest wealth state. Both scenarios start with zero past delayed payments, and 80% of debt over GDP. I consider the low wealth state representative of the Spanish economy [17]. The explosive public consumption process drives public debt up to 95% over GDP in period 4, when the economy reaches the fiscal limit. From that moment on, public delayed payments start to grow, (top center sub figure). The increase in public delayed payments causes the working capital constraint of the firm to be binding, and consequently labor and wages fall down to a 96% and a 90% of their steady states values respectively. Also consumption decreases to 91% of its steady state value. The increase of the savings of the firm is also slowed, as it can be appreciated in bottom left figure. The economy starts with only 20% of its steady state wealth. It end up reaching the steady state level of wealth, but it takes 20 periods. It can be seen in the bottom left of figure 58 that, before the increase of public late payments in period 4, savings of the firm grows very fast, but then stagnates.

In figure 59 I show the simulation for the benchmark model when the economy starts in its steady

[17] According to Amadeus database, in Spain the median leverage of all non financial corporations was 70% in 2011.

state level of wealth. Despite the increase in delayed payments, consumption, labor and wages are around their steady state level during the whole simulation. The conclusion from this exercise is that, if the public supplier is sufficiently wealthy, it can endure trough the crisis without having its optimal decisions altered. This way, the government can finance itself with late payments without distorting consumption and labor.

Figures 60 and 61 present two alternative fiscal regimes. In figure 60, I consider the no fiscal limit model from section 3.5.1, so the government can issue an unbounded amount of debt. In figure 61 I present a dividend tax policy. Both economies start with only 20% of the steady state wealth, i.e. the low wealth state, as in figure 58. In the model without fiscal limit, the government can rise as much sovereign debt as needed, as it can be appreciated in figure 60, top left panel. Debt grows up to 110% of GDP, while in all other figures it cannot grow above 95% of GDP. This allows, as expected, a greater level of consumption than in the low wealth benchmark model. In fact, while debt is going up during the explosive period, the household of the model without fiscal limit can increase labor 5% above the steady state level. In the model with dividend tax policy, when the economy reaches the fiscal limit the government use dividend taxes for equilibrating its budget constraint [18]. Results are in figure 61. The behavior of the variables is very similar to the ones of the benchmark model when the firm start in the high wealth state, figure 59. The main difference is that under the dividend tax policy, it takes more time to the firm to reach the steady state level of wealth. Dividend tax policy discourages savings. To recap, if the economy has access to additional sovereign bonds, then there is not a decrease in labor and consumption during the explosive regime. This could have been the case if the Spanish government could have easy financing during the crisis. Also, if the economy had used dividend tax during the crisis, then it would have avoided the decrease in labor and consumption during the explosive regime. But it would have delayed the growth of the firm. This could be potentially problematic depending on the level of financial restrictions and on the parameter η.

3.6 Conclusion

During the 2008 recession some European governments have relied in delaying payments to their suppliers as a way of equilibrating public balances. In 2011 Spanish, Italian, Portuguese and Greek public

[18]The model with dividend tax policy is fully specified in the appendix.

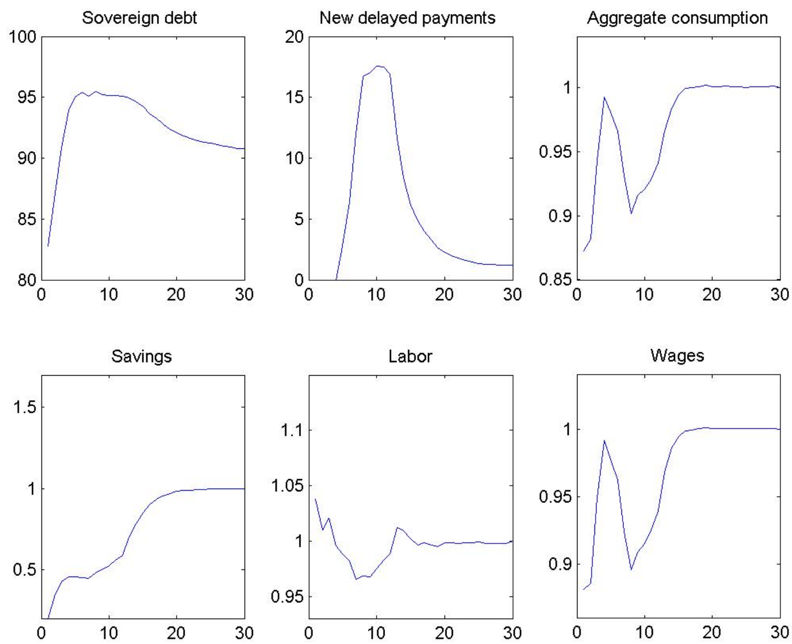


Figure 58: Benchmark model, low wealth firm

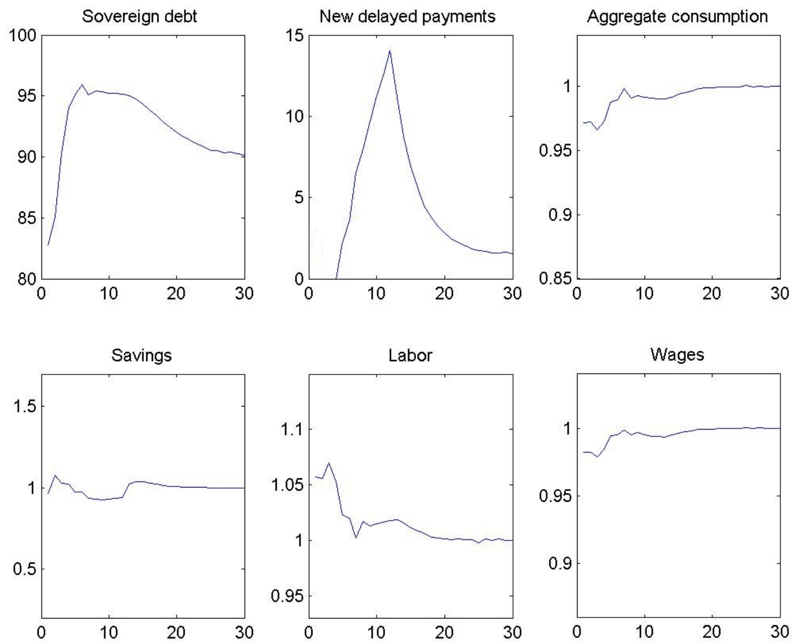


Figure 59: Benchmark model, high wealth firm

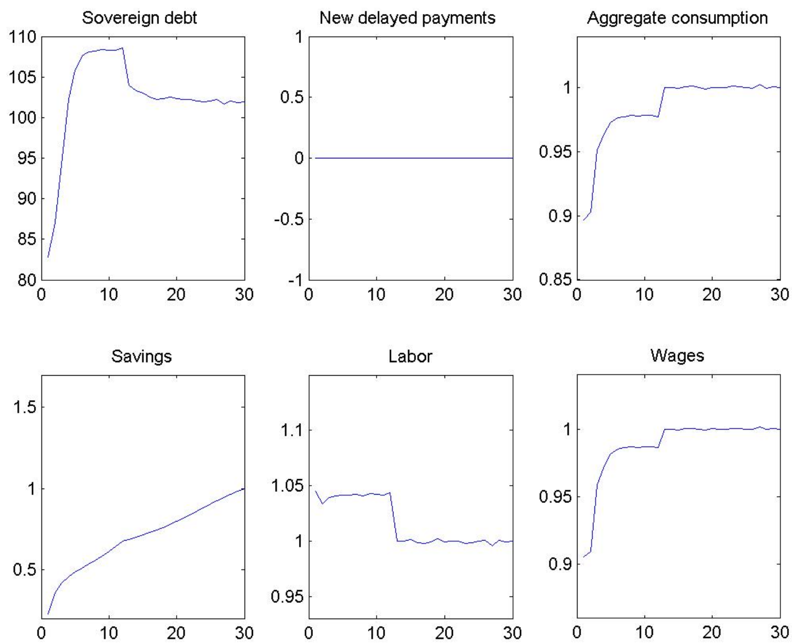


Figure 60: No fiscal limit model, low wealth firm

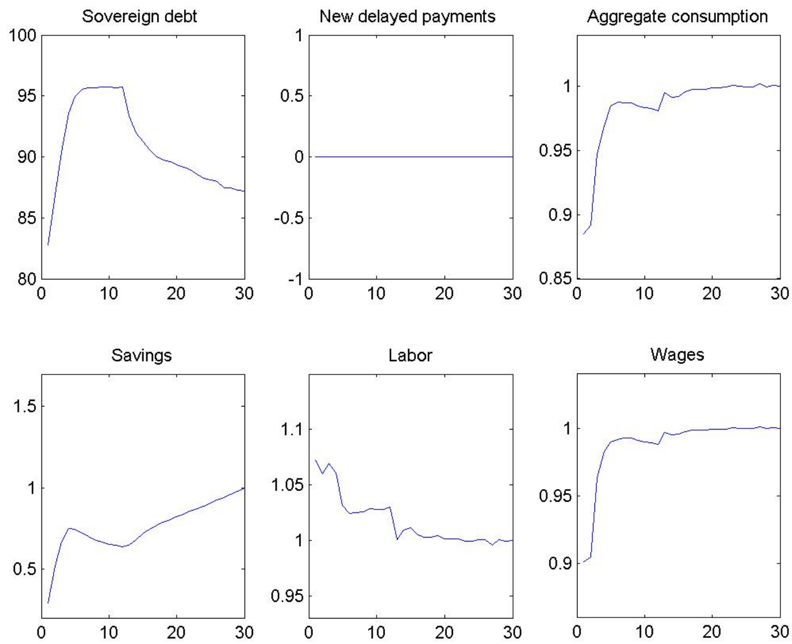


Figure 61: Dividend tax model, low wealth firm

delayed days were three times bigger than the EU average. In addition, these public delayed payments in Spain and Greece accounted up to 8%, Portugal up to 11%, while average of the European Union was around 5%. Therefore, delayed payments appear to be an additional way of equilibrating public finances. Which are the aggregate implications of governments' delayed payments? There exists a trade-off. On the one hand, if the government can delay payments to its suppliers, then it has access to an additional way of funding public expenses and equilibrating its budget constraint. On the other hand, delaying payments to suppliers could have a negative effect on suppliers' production and employment decisions. In this paper I present a novel DSGE model in which the government can finance itself with delayed payments. I show that if the government's supplier has low wealth and/or the government owes high payments, then delaying more payments creates a distortion the economy. Fixing government consumption around 20% of GDP, delayed payments around 8% over GDP, and public debt around 90% (as in Spain in 2011), I show that if the economy is in a low wealth state (firms' debt over assets is 70%) consumption is 5% less in the benchmark model, labor is 10% less and savings are 20% less. Secondly, I compare delayed payments with other fiscal tools. I show that using corporate debt taxes or additional sovereign debt for balance the government budget instead of delayed payment can increase consumption by 10% during the 2008-2012 crisis.

A promising future work could be extending my framework to include two different sectors: private sector and public sector. This way it could be studied how public delayed payments affect the distribution of firms and wages across sectors. Another interesting extension would be to introduce a pricing mechanism between the government and its supplier. It can be interesting to allow public suppliers to adjust the price of their products depending on the late payments of their client, the public sector.

3.7 Appendix

3.7.1 Infinite time simulation and destruction of assets

I simulate the benchmark model a sufficiently large number of periods (50.000 periods) and I compare it with an economy that does not have a fiscal limit, i.e. can raise debt indefinitely. Results are in tables 31 to 33. In those tables I present the ratio of some variables of interest in the benchmark model with respect the economy without fiscal limit. Table 31 shows that both models are practically the same (the only change is in the variance of consumption). This is due to the fact that, in my benchmark model, the representative firm ends up being sufficiently wealthy so that the financial constraints and the delayed payments do not affect it. Consequently, I run two other simulations in which I destroy the wealth of the firm with 10% probability, table 32, and with 20% probability, table 33. The introduction of wealth destruction prevents the firm from accumulating abundant wealth. It can be seen from these tables that, the bigger the probability of destroying the wealth, the lower are consumption, labor and price of bonds, and the higher are savings and the variance of consumption in the benchmark model.

The introduction of wealth destruction has implications for the nonlinear simulations of section 3.5.2. In figures 62 to 65 I present the same analysis as in figures 58 to 61, but wealth is destroyed with probability 10%. It can be seen that for the low wealth benchmark model, the no fiscal model and the dividend tax model, figures 62, 64 and 65, there is no difference with respect the analysis done in section 3.5.2. But for the high wealth benchmark model, figure 63, there is a significant contrast. On the one hand, the fact that wealth can be destroyed decreases considerably the steady state level of wealth. On the other hand, since wealth can be destroyed, a firm with high wealth can be occasionally binding now in the working capital constraint in some simulations. Consequently, consumption, labor and wages are considerably lower with wealth destruction.

	Benchmark model
l_t	1.01
c_t	1.00
a_{t+1}	1.00
$\text{Var}(c_t)$	1.28
q_t	1.00

Table 31: Simulation without destruction

	Benchmark model
l_t	0.99
c_t	0.98
a_{t+1}	1.16
$\text{Var}(c_t)$	2.35
q_t	0.99

Table 32: Simulation destroying assets with probability 10%

$\%change$	Benchmark model
l_t	0.98
c_t	0.97
a_{t+1}	1.21
$\text{Var}(c_t)$	2.44
q_t	0.98

Table 33: Simulation destroying assets with probability 20%

3.7.2 Dividend tax model

This model is similar to the benchmark framework, but now the government can finance its expenses trough the following fiscal instruments: labor income taxes, sovereign bonds and dividend taxes. Divi-

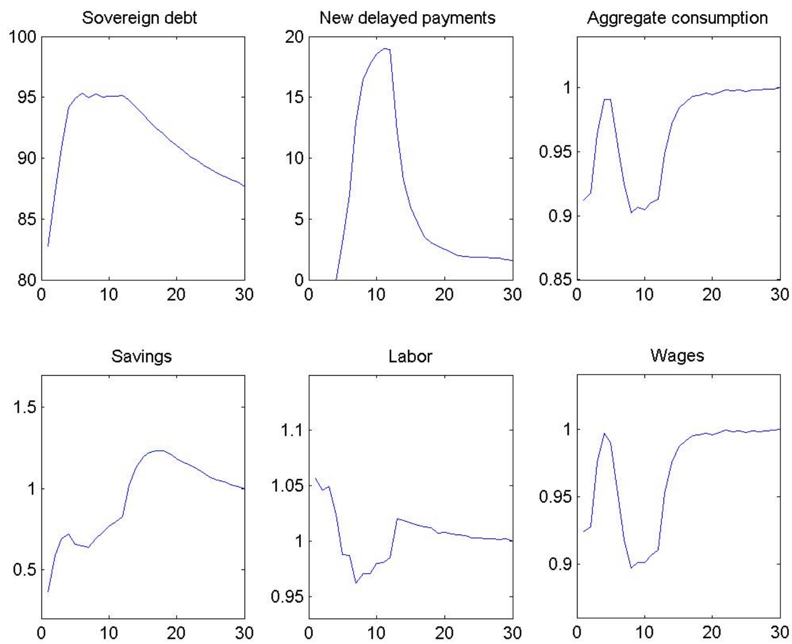


Figure 62: Benchmark model, low wealth firm. Prob of asset destruction 10%

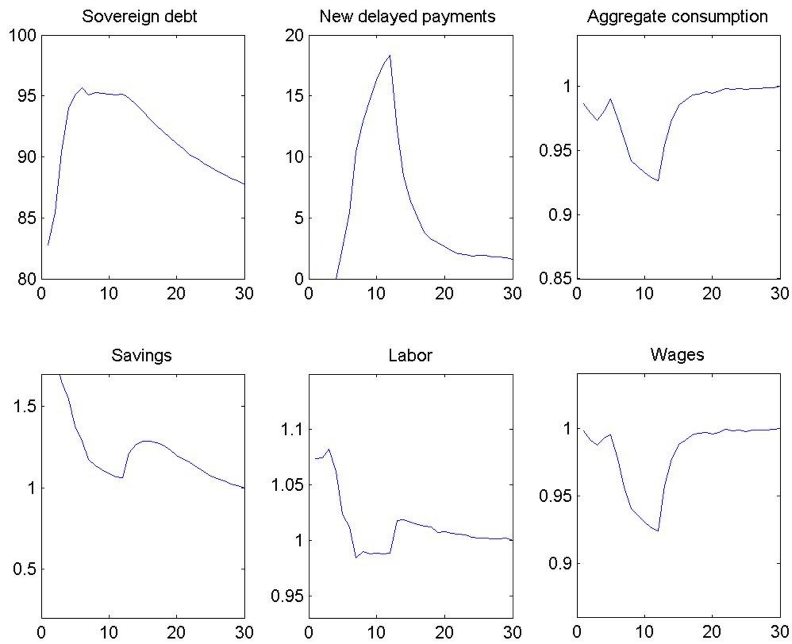


Figure 63: Benchmark model, high wealth firm. Prob of asset destruction 10%

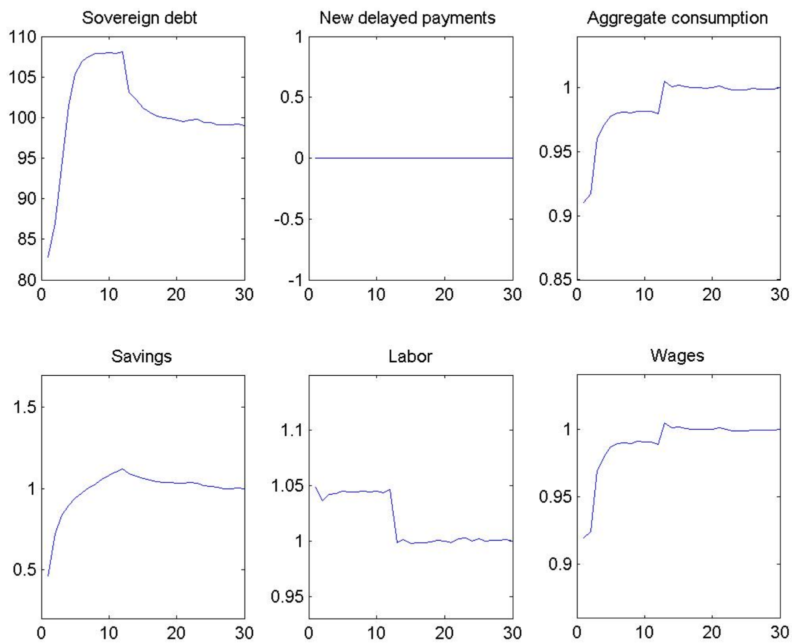


Figure 64: No fiscal limit model, low wealth firm. Prob of asset destruction 10%

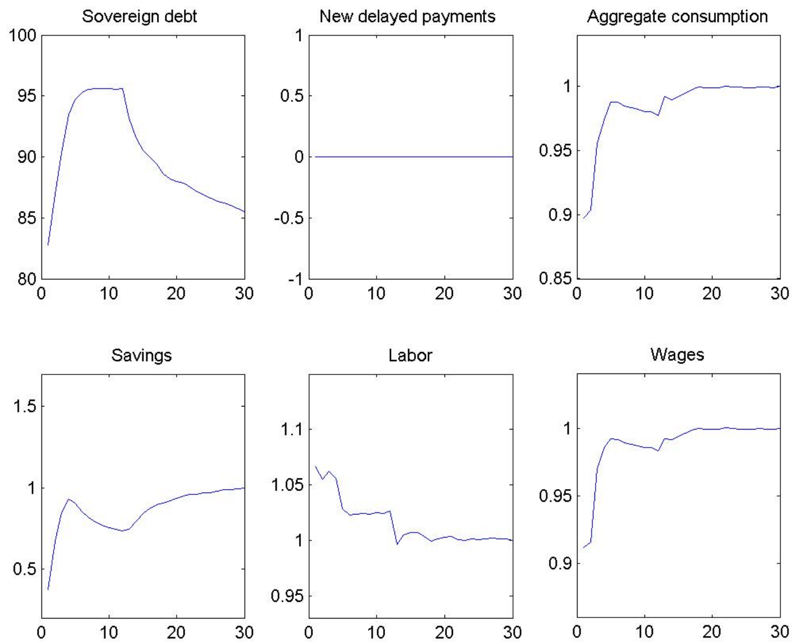


Figure 65: Dividend tax model, low wealth firm. Prob of asset destruction 10%

dend taxes consist on a fraction τ_t^d of dividends of the firm.

In every period, the expenses of the government are defined by the sum of the government's consumption G_t plus past debt b_t. In order to pay for these expenses, the government uses a combination of the three fiscal instruments according to the following fiscal restriction:

$$
\begin{aligned}
&G_t + b_t = \tau_t w_t l_t && \text{if } G_t + b_t \leq T w_t l_t \\
&G_t + b_t = T w_t l_t + q_t b_{t+1} && \text{if } T w_t l_t < G_t + b_t < T w_t l_t + q_t B_t^{limit} \\
&G_t + b_t = T w_t l_t + q_t B_t^{limit} + \tau_t^d d_t && \text{if } G_t + b_t > T w_t l_t + q_t B_t^{limit}
\end{aligned}
$$

To recap, the government needs to cover its expenses each period and it uses the following fiscal rule: First of all, it tries to cover the public expenses with labor income taxes. If taxes are above the institutional limit, then the government issues new debt. And if this new debt is above the fiscal limit, then the government needs to raise dividend taxes.

3.7.3 A model with sovereign default risk

I propose an extension of my framework to introduce sovereign default risk in my benchmark model. This way I can replicate the fact that high sovereign debt interacting with high sovereign spreads implies higher delayed payments by the government. I introduce a simpler version of default of Bi (2012). If the government issues sovereign debt above the default limit in t, then the government partially defaults, and the household only receives a fraction (1-δ_t) of debt in $t+1$. The default limit, $B_t^{default}$ is drawn from a uniform distribution:

$$B_t^{default} \sim \mathrm{U}(0.9B_t^{limit},\, B_t^{limit})$$

This distribution implies that the probability of defaulting is bigger the closer is sovereign debt to the fiscal limit. When b_{t+1} is bigger than 90% of the fiscal limit, the probability of default is bigger than zero. If b_{t+1} is bigger than the fiscal limit, the probability of default is 1. In addition, I assume the following process for the partial default:

$$\delta_t = 0.5(b_{t+1} - B_t^{default})$$

This process implies that, the higher debt, the higher the partial default. This will be reflected in the price of the bond, q_t[19]. Getting close to B_t^{limit} could lead to sovereign default premiums.

Now I compare the performance of the benchmark model with a model that can issue an unlimited amount of bonds. Both models are subject to the partial default scheme. The budget constraint of the government in the benchmark model is:

$$
\begin{aligned}
G_t + (1-\delta_t)b_t + \Delta_t &= \tau_t w_t l_t && \text{if } G_t + b_t + \Delta_t \leq T w_t l_t \\
G_t + (1-\delta_t)b_t + \Delta_t &= T w_t l_t + q_t b_{t+1} && \text{if } T w_t l_t < G_t + b_t + \Delta_t < T w_t l_t + q_t B_t^{limit} \\
G_t + (1-\delta_t)b_t + \Delta_t &= T w_t l_t + q_t B_t^{limit} + \Delta_{t+1} && \text{if } G_t + b_t + \Delta_t > T w_t l_t + q_t B_t^{limit}
\end{aligned}
$$

$$
\phi_t = \left\{ \begin{array}{c} 0 \ \text{ if } \ b_{t+1} < B_t^{default} \\ \delta_t \ \text{ if } \ b_{t+1} > B_t^{default} \end{array} \right\}
$$

The budget constraint of the government in the unlimited bonds model is:

$$
\begin{aligned}
G_t + (1-\delta_t)b_t + \Delta_t &= \tau_t w_t l_t && \text{if } G_t + b_t + \Delta_t \leq T w_t l_t \\
G_t + (1-\delta_t)b_t + \Delta_t &= T w_t l_t + q_t b_{t+1} && \text{if } T w_t l_t < G_t + b_t
\end{aligned}
$$

$$
\phi_t = \left\{ \begin{array}{c} 0 \ \text{ if } \ b_{t+1} < B_t^{default} \\ \delta_t \ \text{ if } \ b_{t+1} > B_t^{default} \end{array} \right\}
$$

Notice that the use of government's delayed payments in the benchmark model reduce the probability of defaulting and the sovereign default risk.

I perform a similar analysis as in section 3.5.1. The analysis is done for the maximum level of government consumption, $\overline{G}$, equal to 20% of GDP, and for an amount of past delayed payments, Δ_t, equal to 8% of GDP. This way I replicate the situation in Spain in 2011. I show the results for three different levels of accumulated wealth and for a large range of past public debt values. The results are shown from figure 66 to figure 70. The low wealth state is displayed with a red cross dotted line, the medium wealth state is displayed with a blue circle dotted line, and the high wealth state is displayed in black line. On the vertical axis it is shown the ratio of each variable under the benchmark model with

[19]From the first order condition of $q_t = \beta \mathbb{E}_t \left((1-\phi_t) \frac{c_t}{c_{t+1}} \right)$.

respect to the no fiscal limit model. On the horizontal axis it is shown different levels of past public debt.

The main conclusions from section 3.5.1 still hold, although there are some interesting new facts. First of all, the benchmark model performs slightly better than in section 3.5.1. This is because the use of delayed payments in the benchmark model prevents the sovereign risk from getting too high. In any case, for the low wealth economy, the benchmark model still implies lower consumption, labor and wages.

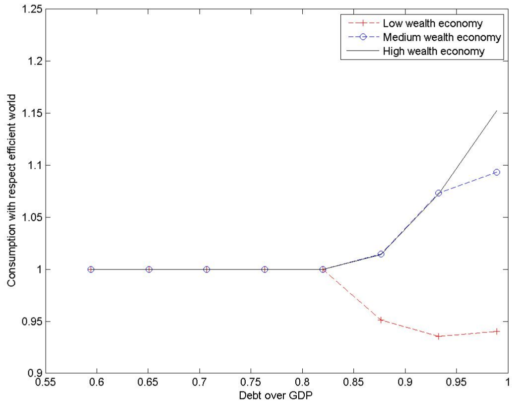


Figure 66: Consumption. Benchmark model with partial default

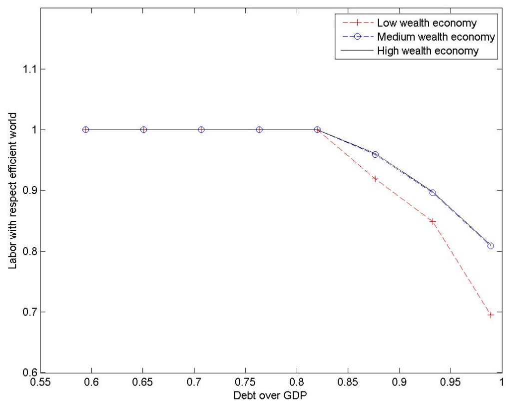


Figure 67: Labor. Benchmark model with partial default

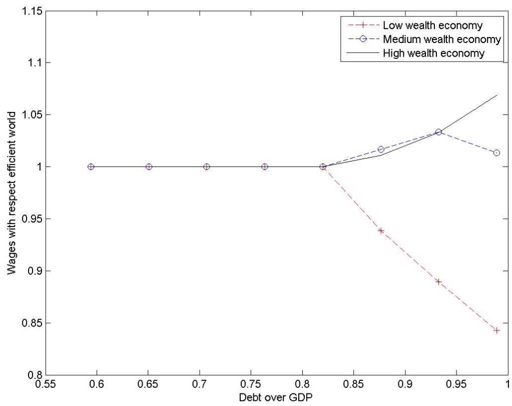


Figure 68: Wages. Benchmark model with partial default

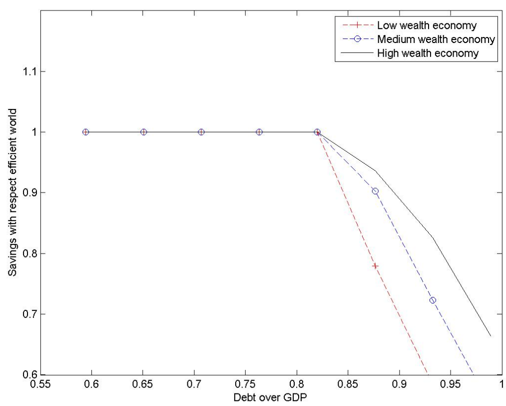


Figure 69: Savings. Benchmark model with partial default

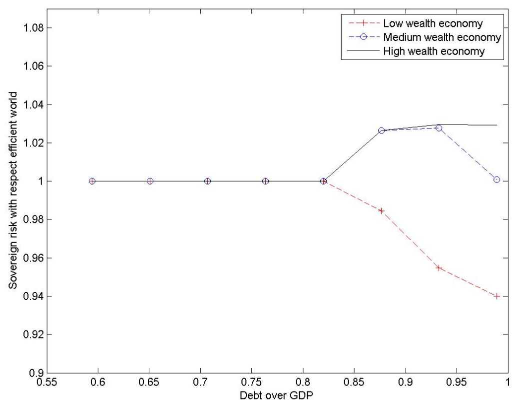


Figure 70: Bond pricing. Benchmark model with partial default

References

[1] Heitor Almeida, Murillo Campello, Bruno Laranjeira, and Scott Weisbenner. Corporate debt maturity and the real effects of the 2007 credit crisis. Technical report, National Bureau of Economic Research, 2009.

[2] Levent Altinoglu. The origins of aggregate fluctuations in a credit network economy. *Working paper*, 2016.

[3] Cristina Arellano. Default risk and income fluctuations in emerging economies. *The American Economic Review*, 98(3):690–712, 2008.

[4] Cristina Arellano, Yan Bai, and Jing Zhang. Firm dynamics and financial development. *Journal of Monetary Economics*, 59(6):533–549, 2012.

[5] Manuel Arellano and Stephen Bond. Some tests of specification for panel data: Monte carlo evidence and an application to employment equations. *The review of economic studies*, 58(2):277–297, 1991.

[6] Efraim Benmelech, Nittai K Bergman, and Amit Seru. Financing labor. Technical report, National Bureau of Economic Research, 2011.

[7] Samuel Bentolila, Marcel Jansen, Gabriel Jiménez, and Sonia Ruano. When credit dries up: Job losses in the great recession. Technical report, CESifo Working Paper, 2013.

[8] Ben S Bernanke and Alan S Blinder. Credit, money, and aggregate demand, 1989.

[9] Huixin Bi. Sovereign default risk premia, fiscal limits, and fiscal policy. *European Economic Review*, 56(3):389–410, 2012.

[10] Huixin Bi and Eric M Leeper. Sovereign debt risk premia and fiscal policy in sweden. Technical report, National Bureau of Economic Research, 2010.

[11] Richard Blundell and Stephen Bond. Initial conditions and moment restrictions in dynamic panel data models. *Journal of econometrics*, 87(1):115–143, 1998.

[12] Tito Boeri, Pietro Garibaldi, and E Moen. Labor and finance: Mortensen and pissarides meet holmstrom and tirole. Technical report, mimeo, Bocconi University, 2013.

[13] Andra Buca and P Vermuelen. Corporate investment and bank-dependent borrowers during the recent financial crisis. *European Central Bank*, 2012.

[14] Francisco J Buera and Yongseok Shin. Financial frictions and the persistence of history: A quantitative exploration. *Journal of Political Economy*, 121(2):221–272, 2013.

[15] Luis MB Cabral and Jose Mata. On the evolution of the firm size distribution: Facts and theory. *American economic review*, pages 1075–1090, 2003.

[16] Cristina Checherita-Westphal, Alexander Klemm, and Paul Viefers. Governments payment discipline: The macroeconomic impact of public payment delays and arrears. *Journal of Macroeconomics*, 47:147–165, 2016.

[17] Gabriel Chodorow-Reich. The employment effects of credit market disruptions: Firm-level evidence from the 2008–9 financial crisis. *The Quarterly Journal of Economics*, 129(1):1–59, 2014.

[18] Thomas F Cooley and Vincenzo Quadrini. Financial markets and firm dynamics. *American Economic Review*, pages 1286–1310, 2001.

[19] Nicolas Crouzet. Aggregate implications of corporate debt choices. *Working paper*, 2014.

[20] Vicente Cunyat. Trade credit: suppliers as debt collectors and insurance providers. *Review of Financial Studies*, 20(2):491–527, 2007.

[21] Troy Davig, Eric M Leeper, and Todd B Walker. Inflation and the fiscal limit. *European Economic Review*, 55(1):31–47, 2011.

[22] Fiorella De Fiore and Harald Uhlig. Bank finance versus bond finance. *Journal of Money, Credit and Banking*, 43(7):1399–1421, 2011.

[23] Harry DeAngelo, Linda DeAngelo, and René M Stulz. Dividend policy and the earned/contributed capital mix: a test of the life-cycle theory. *Journal of Financial economics*, 81(2):227–254, 2006.

[24] Mar Delgado Tellez, Pablo Hernandez de Cos, Samuel Hurtado, and Javier.J Perez. Extraordinary mechanisms for payment of general government suppliers in spain. *Banco de Espanya Occasional paper*, (1501), 2015.

[25] Pablo D'Erasmo and Enrique G Mendoza. Distributional incentives in an equilibrium model of domestic sovereign default. *Journal of the European Economic Association*, 14(1):7–44, 2016.

[26] Jonathan Eaton and Mark Gersovitz. Debt with potential repudiation: Theoretical and empirical analysis. *The Review of Economic Studies*, 48(2):289–309, 1981.

[27] Martin Feldstein. The effect of marginal tax rates on taxable income: a panel study of the 1986 tax reform act. *Journal of Political Economy*, 103(3):551–572, 1995.

[28] Luis Garicano and Claudia Steinwender. Survive another day: does uncertain financing affect the composition of investment? 2013.

[29] Robert Gibrat. *Les inégalités économiques.* Recueil Sirey, 1931.

[30] Maria Gonzalez. *Nonfinancial firms in Latin America: A source of vulnerability?* Number 12-279. International Monetary Fund, 2012.

[31] Luca Guerrieri and Matteo Iacoviello. Occbin: A toolkit for solving dynamic models with occasionally binding constraints easily. *Journal of Monetary Economics*, 70:22–38, 2015.

[32] Urban Jermann and Vincenzo Quadrini. Macroeconomic effects of financial shocks. *The American Economic Review*, 102(1):238–271, 2012.

[33] Instrum Justitia. European payment index, 2004-2016. Technical report.

[34] Sebnem Kalemli-Ozcan, Bent Sorensen, and Sevcan Yesiltas. Leverage across firms, banks, and countries. *Journal of international Economics*, 88(2):284–298, 2012.

[35] Aubhik Khan and Julia K. Thomas. Credit shocks and aggregate fluctuations in an economy with production heterogeneity. *Journal of Political Economy*, 121(6):pp. 1261–1263, 2013.

[36] Ciarán Mac an Bhaird. Resourcing small and medium sized enterprises. 2010.

[37] Tommaso Monacelli, Vincenzo Quadrini, and Antonella Trigari. Financial markets and unemployment. Technical report, National Bureau of Economic Research, 2011.

[38] Giuseppe Moscarini and Fabien Postel-Vinay. The timing of labor market expansions: new facts and a new hypothesis. In *NBER Macroeconomics Annual 2008, Volume 23*, pages 1–51. University of Chicago Press, 2009.

[39] Stephanie Schmitt-Grohé and Martin Uribe. What's news in business cycles. *Econometrica*, 80(6):2733–2764, 2012.

[40] Joseph A Schumpeter. *Capitalism, socialism and democracy.* Routledge, 1942.

[41] Lin Shao. Aggregate fluctuations and the role of trade credit. *Working paper*, 2016.

[42] Torsten Sløk and Mike Kennedy. Corporate sector vulnerability and aggregate activity. *OECD Economic Studies*, 2005(1):85–110, 2005.

[43] Martin Uribe and Vivian Z Yue. Country spreads and emerging countries: Who drives whom? *Journal of international Economics*, 69(1):6–36, 2006.

[44] Bureau van Dijk. Database of financial information. Technical report, 2013.